

CAREX REZNICEKII, A NEW WIDESPREAD SPECIES OF CAREX SECTION ACROCYSTIS (CYPERACEAE) FROM EASTERN NORTH AMERICA

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ABSTRACT

Carex reznicekii is described as new from mesic to dry-mesic forests of Alabama, Arkansas, Connecticut, Delaware, District of Columbia, Georgia, Kentucky, Maryland, Mississippi, Missouri, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina, Tennessee, and Virginia. Previously, *C. reznicekii* had mostly been misidentified as either *C. umbellata* or *C. nigromarginata*. It is distinguished from these species as well as other members of section *Acrocystis* by a combination of lack of basal spikes, short culms, narrow leaves, and only slightly red pistillate scales. A key to the 19 taxa of section *Acrocystis* that occur in eastern North America is provided.

RESUMEN

Se describe como nuevo **Carex reznicekii** de los bosques mésicos a xérico-mésicos de Alabama, Arkansas, Carolina del Norte, Carolina del Sur, Connecticut, Delaware, Distrito de Columbia, Georgia, Kentucky, Maryland, Mississippi, Missouri, New Jersey, New York, Pennsylvania, Rhode Island, Tennessee, y Virginia. Previamente, *C. reznicekii*, había estado en su mayor parte mal interpretada como *C. umbellata* o *C. nigromarginata*. Se distingue de estas especies así como de otros miembros de la sección *Acrocystis* por la combinación de carencia de espiga basal, cúlmenes cortos, hojas estrechas, y escamas femeninas sólo levemente rojas. Se proporciona una clave para los 19 taxa de la sección *Acrocystis* que ocurren en el este de Norteamérica.

INTRODUCTION

Carex section *Acrocystis* Dumort. contains approximately 35 species worldwide with 20 in North America (Crins & Rettig 2002), although the most recent comprehensive treatment is Kükenenthal's (1909) now outdated revision. Species distributions lie mostly in Eurasia and North American with one taxon known from South America (Kükenenthal 1909). It appears that *Carex* section *Acrocystis* as currently circumscribed is polyphyletic, but North American species and some Eurasian species form a clade (Roalson et al. 2001; Roalson & Friar 2004). Twenty-eight taxa, including the one described here, are currently known from North America, with 19 of these occurring in eastern North America (Crins & Rettig 2002). At least two additional undescribed species occur in eastern North America (Crins & Rettig 2002; Roalson & Friar 2004; Anton Reznicek, pers. comm.).

Eastern North American taxa of section *Acrocystis*, share the following characters: perigynia pubescent (except *C. tonsa* (Fernald) Bicknell var. *tonsa*), two veined, and abruptly narrowed to a distinct beak; stigmas three (except two and three in *C. floridana* Schwein.); non-basal pistillate spikes (when present) subtended by sub-sheathing to sheathless bracts, approximate, the distal ones short pedunculate to sessile; and habitats dry to mesic forests (tending to favor drier) or more open for a few taxa.

During survey work in the Hudson Highlands of southeastern New York, I found a

population of the New York State endangered *C. nigromarginata*. While delineating and describing this population I encountered a population of a strikingly different plant, which at first appeared to be *C. umbellata* because all of its culms were very short and hidden in the bases of the plants. Upon closer inspection, I observed that these short-culmed plants lacked the basal spikes characteristic of *C. umbellata*. These short-culmed plants were uniform throughout its population and appeared immediately adjacent to and clearly did not resemble *C. nigromarginata*. In contrast to the *C. nigromarginata* population, these short-culmed plants had much narrower leaves, uniformly very short culms, and pale pistillate scales. Wider sampling showed that the short-culmed plants formed discreet uniform populations, although sometimes occurring mixed with, but seemingly not intergrading with, *C. nigromarginata*. A cursory examination of herbarium material also suggested that the distributions of the two entities were different. This new species of *Carex* is described here as *Carex reznicekii*.

MATERIALS AND METHODS

Specimens of *C. reznicekii* were sought by examining all specimens labeled as *C. nigromarginata* Schwein. and *C. umbellata* Schkuhr ex Willd. (two superficially similar species) and in some cases other members of section *Acrocystis* from BH, BRIT, GH, MO, NCU, NY, NYS, PH, and US. In addition, putative *C. reznicekii* specimens were sent to me from collections at DOV, MICH, and VPI as well as by Philip E. Hyatt. Additional specimens were gathered from field work. Type material was examined of all species similar to or confusable with *C. reznicekii*, including their synonyms.

Thirty-one populations were visited in the field, covering a large part of the species' range. Site visits were conducted to assess habitat affinities, morphological variability, and habitat differences with other members of *Carex* section *Acrocystis*. Soil samples were collected at six distant sites throughout a large part of the range of the species (Fig. 1). Equal amounts of soil from four places at each of the six sites (adjacent to individual *C. reznicekii* plants) that were at least 10 meters apart were mixed together. These were sent to Cornell Nutrient Analysis Laboratories at Cornell University, Ithaca, NY for analysis. Soils were analyzed for particle size distribution, pH, and the minerals Al, Ca, Fe, K, Mg, Mn, P, and Zn.

To clarify the differences between *C. nigromarginata*, the most similar species to *C. reznicekii*, and *C. reznicekii*, specimens were compared using eight continuous characters (see Table 1). Specimens were selected so as to have ten specimens per species from each of three geographic regions: 1) northeast (Virginia/Kentucky north), 2) southeast (North Carolina/Tennessee south), and 3) Arkansas/Missouri. Only six adequate specimens were available for *C. reznicekii* from the latter region. Within each geographic region (excluding Arkansas/Missouri), only two specimens per state and one per county were selected to help cover the range of the species. For each species, specimens were selected randomly given the parameters mentioned above and excluding specimens where all eight characters could not be measured. Analysis of variance (two-way ANOVA) and Pearson Correlation Coefficients were calculated using SPSS Version 13. Additionally, ranges, means, and standard deviations were calculated for both species for each region.

Nonmetric multidimensional scaling (NMDS) ordination was chosen to compare the relationship of *C. nigromarginata* and *C. reznicekii*. In comparison to other ordination methods such as canonical correspondence analysis (CCA) or principle components analysis (PCA), NMDS does not assume an underlying distribution for measured vari-

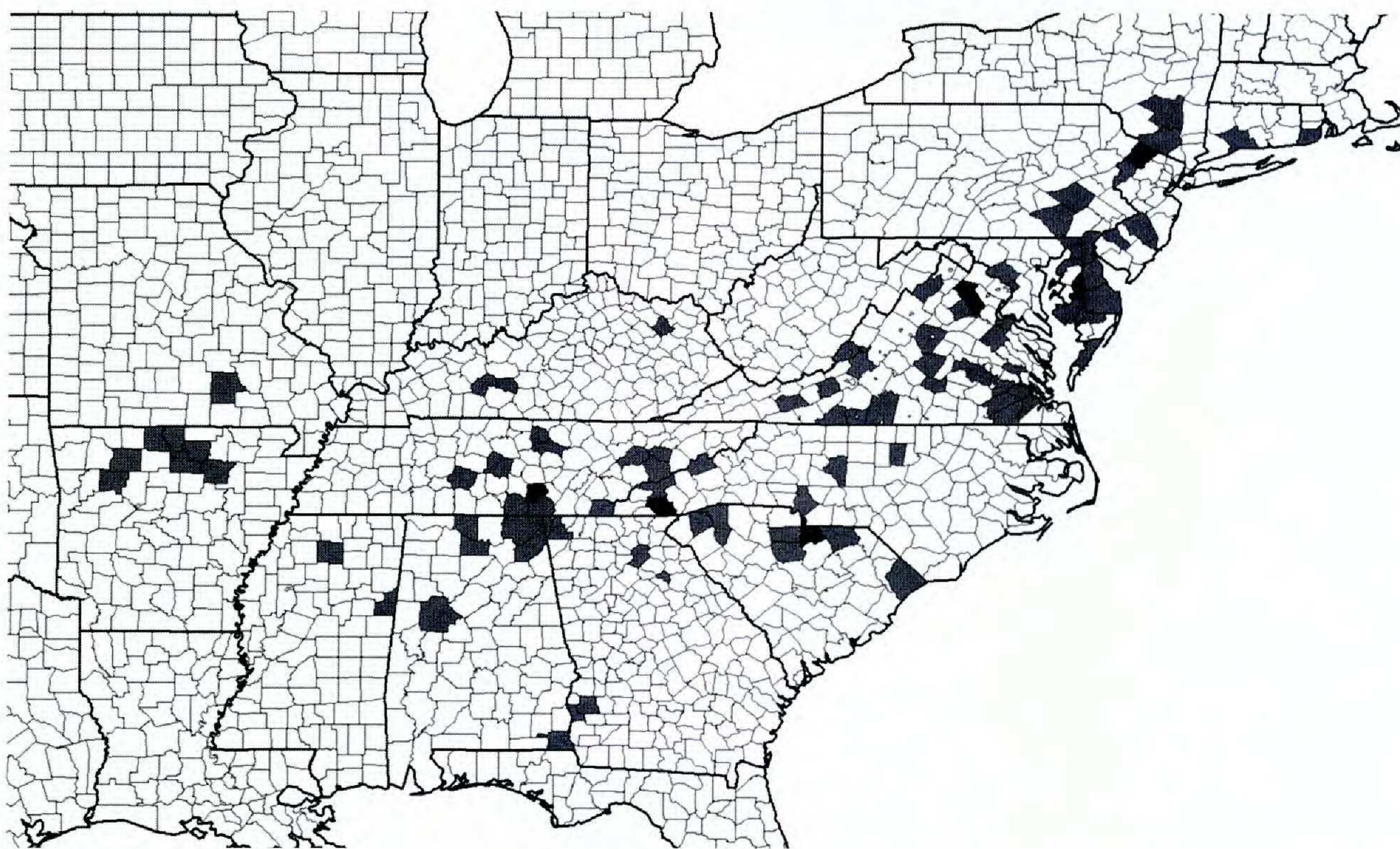


FIG. 1. Geographic distribution of *C. reznicekii*. Soil samples collected in blackened counties.

ables. A NMDS ordination was created using the slow thorough mode on PC-ORD (McCune & Grace 2002). Specimens measured for use in the ordination are delineated by a single asterisk in the isotypes listed for *C. reznicekii*, in the representative specimens of *C. reznicekii*, and in the specimens cited in Appendix A.

A scatter plot graph using a larger sample size was created for the two most explanatory characters. As additional evidence that *C. reznicekii* and *C. nigromarginata* are discrete entities, distribution curves were created and compared for the two most explanatory characters for *C. nigromarginata* and *C. reznicekii*, as well as *C. nigromarginata* and *C. reznicekii* combined, and *C. nigromarginata* specimens from outside the geographic range of *C. reznicekii*. For the latter distribution curves all specimens of *C. nigromarginata* that occur outside of the geographic range of *C. reznicekii* from BH, BRIT, MICH, and MO, excluding duplicates, were measured. Specimens measured for the scatter plot graph and distribution curves are delineated by either a single or double asterisk in the isotypes listed for *C. reznicekii*, in the representative specimen of *C. reznicekii*, and in the specimens cited in Appendix A.

A description of *C. reznicekii* and a key to all members of *Carex* section *Acrocystis* were created from original measurements except, for the key, measurements for *C. communis* Bailey varieties and *C. inops* Bailey ssp. *heliophila* (Mackenzie) Crins are adapted from Crins and Rettig (2002). Character states that were on an extreme edge or disjunct from most other measurement are placed in parentheses. The following notes clarify three characters listed in the description and the key.

1. Culm length is measured from the base of the culm to the top of the inflorescence as interpreted or implied by many other authors (LeBlond et al. 1994; Reznicek & Camelbeke 1996; Naczi et al. 2001; and others).

2. Terminal staminate spikes exceeding or exceeded by the rest of the inflorescence is

TABLE 1. Characters measured for ordination, ANOVA, and Pearson Correlations giving the codes used throughout the paper and any specifications for choosing which part to measure.

Character	Code	Specifications
Tallest culm height (cm)	TaCuHe	Tallest per specimen
Widest leaf width (mm)	WiLeWi	Widest per specimen
Anther length (mm)	AnLe	Mean of two per specimen
Largest length that a staminate spike exceeds the distal most pistillate spike (mm)	StSpExPiSp	Greatest length per specimen
Perigynia length (mm)	PeLe	Mean of two per specimen
Perigynia width (mm)	PeWi	Mean of two per specimen
Taller staminate spike length (mm)	StSpLe	Mean of the length of two taller staminate spikes per specimen
Staminate spike width (mm)	StSpWi	Mean of the width of the two staminate spikes measured for spike length

measured by subtracting the difference of the length from the base of the bract subtending the proximal-most non-basal spike to the apex of the terminal staminate spike, and the length from the base of this same bract to the apex of the distal most lateral spike.

3. Perigynium body refers to the perigynium excluding the beak and stipe or stipe-like base. The beak and stipe begin at the deepest point in the concavity formed at the summit and base of the perigynium. Perigynium body shapes vary considerably and although their shape aids in distinguishing taxa (and is used in the key), they should be used cautiously.

RESULTS

Carex reznicekii Werier, sp. nov. (**Fig. 2**). TYPE: U.S.A. VIRGINIA. Caroline Co.: near North Anna River, Route 207 (Jericho Road) W from Carmel Church to Oxford Road (Route 689), 3.6 mi S and SE on Oxford Road (Route 689) to small dirt road on S side of road; SW along dirt road towards North Anna River, UTM coordinates in NAD-83 Zone 18 4196701N 280996E, 10 Apr 2004, *Werier 1951* (HOLOTYPE: BH; ISOTYPES: GH*, MICH, MO, NCU, NY, US).

Carici nigromarginatae similis, sed characteribus sequentibus differt: laminis foliorum latissimis 1.2–2.2(–2.5) mm latis; culmis singulae plantae saepe in longitudine similibus longissimis 1.9–9.9(–13.7) cm longis, spicis staminalibus 3.3–8.3(–9.2) mm longis et 0.4–1.6(–1.8) mm latis; et colore rubenti squamarum pistillatarum ad regiones marginales restricto.

Densely caespitose, herbaceous, evergreen perennial. **Rhizomes** horizontal, ascending, or erect, 0.1–3.8 mm long between shoots or branches of the rhizomes, 0.6–1.2 mm wide with leaf sheaths absent, enclosed by leaf sheaths and/or cataphylls, which disintegrate into long fibers. **Vegetative shoots** erect to ascending, arising from buds at the tip or side of the rhizomes, or directly from the apical meristem of rhizomes or previous year’s vegetative shoots; bases consisting of cataphylls or leaf sheaths which disintegrate into long fibers; **pseudoculms** (represented by leaf sheaths) 1.2–7.6 cm long. **Reproductive shoots** erect, mostly produced directly from the apical meristem of vegetative shoots or rhizomes, or less frequently produced from buds at tip or side of rhizomes, bases mostly surrounded only by leaf sheaths which disintegrate into long fibers, or less frequently surrounded by cataphylls; **culms** 1.3–9.9(–13.7) cm long, the tallest 1.9–9.9(–13.7) cm long, 0.3–0.5 mm wide just below the inflorescence, trigonous, with 1 elevated vein on each angle and 2–5 elevated veins on each side, smooth to minutely antrorsely scabrous on angles and veins,



FIG. 2. *Carex reznicekii*. **Bottom right**, plant (scale = 5 cm). **Bottom left**, Pistillate scales, perigynia, and achenes (scale = 1 mm). **Middle** (l to r), culm, inflorescence, and sheath (scale = 1 cm). **Top left**, staminate scale and anther (scale = 1 mm).

more prominently scabrous on angles and distally. **Cataphylls** at base of reproductive shoots 0–2, 1.6–10.8 mm long. **Leaves of reproductive shoots** 3–9. **Leaf blades** to 52.0 cm long, 0.7–2.2(–2.5) mm wide, the widest 1.2–2.2(–2.5) mm wide, flat to V-shaped, to occasionally M-shaped; adaxial surface dark green and smooth, papillose, or antrorsely scabrous, more textured distally; abaxial surface smooth to occasionally scabrous, more textured on mid-vein and distally; margins smooth to antrorsely scabrous, more scabrous distally; **leaf sheaths** 0.7–5.1 cm long, lower portion especially on outer sheaths have some red coloration; abaxial face with green to white or proximally red veins and whitish and translucent to proximally reddish and more opaque intervein regions; adaxial face with whitish or proximally red veins and whitish, thin, and translucent intervein regions, thinner and more translucent than abaxial intervein regions; vein edges with ascending, spreading, or reflexed minute, stiff, broad-based deltoid hairs; sheaths disintegrate into long fibers consisting of veins, which retain pubescence; adaxial sheath face apex concave to a depth of 0.3–0.8(–1.0) mm and sometimes slightly thickened; **ligules** typically wider than long, 0.3–1.0(–1.5) mm long (including the free portion), 0.6–1.4 mm wide, free portion of ligule 0.1–0.2 mm long, ciliate with abundant minute, stiff, broad-based deltoid hairs. **Infructescences** 5.2–12.9(–16.7) mm long, consisting of 3–5 approximate spikes at the summit of the culm; **proximal-most internode** 0.8–3.7(–5.2) mm long; **bracts** sheathless; **proximal-most bract** with blade 3.6–23.0(–38.5) mm long, 0.6–1.8 mm wide, 3.9(–4.3) mm shorter than to 10.9(–23.5) mm taller than infructescences; distal bracts reduced. **Spikes** arising singly from nodes; **terminal spike** staminate, 3.3–8.3(–9.2) mm long, 0.4–1.6(–1.8) mm wide, on peduncle (0.2–)0.3–0.7 mm long, exceeding distal-most lateral spike by 3.7 mm to exceeded by distal-most lateral spike by 1.1(–1.6) mm; **lateral spikes** 2–4, pistillate, short-pedunculate, with a cladophyll towards base of peduncle; **proximal-most spikes** 3.4–7.2 mm long, (1.8–)2.2–4.4 mm wide, (3–)5–10(–12) flowered, on peduncles (0.3–)0.4–0.9(–1.4) mm long, with cladophyll (0.7–)1.7–2.8(–3.0) mm long. **Staminate scales** (2.5–)2.7–4.0 mm long, 0.7–1.8 mm wide, ovate to elliptic, apex acute to obtuse, with a green or yellowish longitudinal mid-stripe which includes the mid-vein, margins translucent, thin, whitish to occasionally yellowish-brown, often red sub-marginally forming a longitudinal stripe, more so toward apex of scales and on distal scales; mid-vein present, extending further toward the apex of the scale in more distal scales; distal scales with mid-vein raised, slightly antrorsely scabrous, and ending close to apex of scale or sometimes with mid-vein projecting as a short awn attached just proximal to the scale apex and projecting up to just beyond the apex of the scale; **Pistillate scales** 2.6–4.3 mm long, 1.0–1.9 mm wide, 0.9(–1.1) mm shorter than to 0.5 mm longer than associated perigynium, ovate to lanceolate to elliptic, apex acute to obtuse, with a green (to brownish) longitudinal mid-stripe which includes the mid-vein; margins translucent, thin, whitish to occasionally yellow-brown, often some reddish color sub-marginally forming a sub-marginal longitudinal stripe, more so distally on the scale; sub-marginal longitudinal red stripe (if present) does not extend laterally to immediately adjacent to mid-stripe except sometimes at apex of scale; mid-vein antrorsely scabrous and ending just before apex of scale or mid-vein, projecting as a short awn attached just proximal to the scale apex and projecting up to just beyond the apex of the scale; bases of scales often with a narrow red horizontal stripe just above attachment to spike axis. **Anthers** 3, (1.2–)1.3–1.9(–2.3) mm long. **Stigmas** 3, withering with age. **Perigynia** (2.5–)2.7–3.9 mm long, (0.8–)0.9–1.3(–1.5) mm wide, light green, occasionally sparsely red-punctate, obtusely trigonous to plano-convex in cross-section, with two prominent nerves that extend the length of the perigynia and occasion-

ally up to 8 less prominent nerves at base, papillose with papillae short-cylindric up to 0.01 mm long, as well as pubescent with small (less than 0.1 mm), predominately antrorsely directed, stiff, deltoid hairs, which are denser on the prominent nerves that extend into the beak teeth; **body** 1.4–1.9(–2.0) mm long, ellipsoid, gradually tapering to beak and stipe; **stipe** 0.5–1.0(–1.1) mm long; **beak** (0.4–)0.6–1.0 mm long, bidentate; **beak teeth** 0.1–0.3 mm long. **Achenes** (1.4–)1.5–1.8(–1.9) mm long, 0.9–1.2(–1.3) mm wide, ovoid, acutely to obtusely trigonous to plano-convex in cross-section, minutely papillose, yellow-green to green when immature, light to chestnut brown when mature.

Etymology.—I selected *reznicekii* as the epithet to honor Dr. Anton Reznicek, University of Michigan, who has inspired me and many others interested in carices. He has catalyzed a revival in the study of *Carex* which has revealed a tremendous amount of new information. In addition, he has contributed directly to a greater understanding of these plants through numerous articles and classes.

A total of 242 specimens (143 records) of *C. reznicekii* were examined. Of these, 125 specimens (88 records) were collections made prior to recognition of *C. reznicekii*. Seventy-one of these 125 specimens had at one point been labeled *C. nigromarginata*, 78 *C. umbellata* (including *C. abdita* Bicknell and *C. umbellata* var. *brevirostris* Boott), 6 *C. floridana* [including *C. nigromarginata* var. *floridana* (Schwein.) Kükenthal], and 9 *C. albicans* Willd. ex Spreng. var. *emmonsii* (Dewey ex Torr.) Rettig [including *C. emmonsii* Dewey ex Torr. and *C. nigromarginata* var. *minor* (Boott) Gleason]. The sum totals to more than 125 because some specimens had been annotated numerous times.

Type material examined comprised the following: *C. umbellata*, scan of holotype from B; *C. umbellata* var. *vicina* Dewey, holotype at GH, isotype at PH; *C. umbellata* var. *brevirostris*, isotype at US (holotype not examined but specimen is from Saskatchewan); *C. abdita*, holotype at NY; *C. microrhyncha* Mackenzie, holotype at NY; *C. umbellata* var. *tonsa* Fernald, lectotype and 2 isoelectotypes at GH; *C. rugosperma* Mackenzie, holotype at NY; *C. nigromarginata*, holotype at PH; and *C. floridana*, holotype at PH. None of the types examined proved to be *C. reznicekii*.

A detailed comparison of *C. reznicekii* to *C. umbellata* and *C. nigromarginata* is made below. In the past, *C. reznicekii* has been mistaken most often for these two species. *Carex nigromarginata* is most similar. The key compares all members of section *Acrocystis* from eastern North America.

Carex umbellata superficially resembles *C. reznicekii*, but is actually quite distinct. The two species can easily be fully separated by noting the presence (*C. umbellata*) or absence (*C. reznicekii*) of basal spikes. Mackenzie (1913), clearly stated this when he explained how to distinguish *C. nigromarginata* and *C. floridana* from *C. umbellata* and its allies. He stated, “these [*C. nigromarginata* and *C. floridana*] are to be distinguished by the fact that while the spikes are on very short culms and may appear basal they are not on basal peduncles.” Fernald (1902) apparently did not understand the concept of basal spikes when he stated that “the best means of distinction between *C. umbellata* [misapplied to *C. tosa* var. *rugosperma* (Mackenzie) Crins] and *C. nigro-marginata* [sic.] is offered by the thickness of the perigynia.” In his 8th edition of Gray’s Manual, Fernald (1950) placed *C. nigromarginata* with the basal spike members of section *Acrocystis* (as *Montanae* Fries) and then used perigynium characters and geographic region to distinguish *C. nigromarginata* from *C. umbellata* and its allies. This means of distinction appears to have been followed by at least Cusick (1992) and Tucker (1995), and may have in part resulted in *C. reznicekii* often being misidentified as *C. umbellata*.

Other characters that separate *C. umbellata* from *C. reznicekii* include the following: *C. umbellata* has staminate spikes with 0–2 approximate pistillate spikes vs. 2–4 for *C. reznicekii*; some pistillate spikes on elongate peduncles vs. none on elongate peduncles for *C. reznicekii*; staminate spikes extending up to 9.0 mm beyond the approximate (if present) pistillate spikes vs. staminate spikes at most extending 3.7 mm beyond the pistillate spikes for *C. reznicekii*; and perigynia (2.2–)2.3–3.2(–3.3) mm long vs. perigynia (2.5–)2.7–3.9 mm long for *C. reznicekii*. In addition, leaf blades of *C. umbellata* are generally lighter green and slightly wider than *C. reznicekii*.

A full understanding of basal spikes seems particularly important to understanding the difference between these two species, and may enrich the understanding of section *Acrocystis* as a whole. Basal spikes are individual pistillate spikes which arise almost directly from the base of the plant [subradical of Mackenzie (1913)]. These pistillate spikes have elongated peduncles, and as with all pistillate spikes in section *Acrocystis*, they are subtended by bracts. These bracts have sheaths and blades [contrary to Mackenzie (1935) and Roalson and Friar (2004) that state that section *Acrocystis* (*Montanae* of Mackenzie) has bracts which are sheathless or subsheathing]. These authors probably meant that bracts of **non-basal spikes** are sheathless or subsheathing. In addition, the culms of *C. umbellata* (defined as from the bases of the culms to the apices of the inflorescences) are often much taller than the apices of the basal pistillate spikes. Roalson and Friar (2004) consider basal pistillate spikes to be better described as a continuous character with somewhat distinct states, as opposed to a discrete character. While in essence this could be true, it appears that this character functions in two completely distinct states with associated other characters (elongated peduncles and sheathing bracts). Even more interestingly, while neither *C. nigromarginata* nor *C. reznicekii* has basal spikes, both often have “grouped culms.” These “grouped culms” have one culm which is taller and one to three which are shorter (much less pronounced in *C. reznicekii*), mimicking the tall and short aspect of *C. umbellata*, with its often tall culms and shorter basal pistillate spike peduncles. In addition, the shorter culms in a “group” of culms in *C. nigromarginata* and *C. reznicekii* have relatively shorter and less projecting terminal staminate spikes.

Carex reznicekii and *C. nigromarginata* share a few characters, including no basal spikes, no elongated rhizomes, at least some culms short and hidden in leaf bases, perigynia of similar length, stigmas 3, and inflorescences composed of 3–5 approximate spikes. Likely because of these similarities, *C. reznicekii* has often been misidentified as *C. nigromarginata*.

Several characters separate these two species. First, *C. reznicekii* has narrower leaves with the widest per plant 1.2–2.2(–2.5) mm wide vs. (1.9–)2.3–4.5 mm wide for *C. nigromarginata*. Second, the tallest culms per plant are shorter. For *C. reznicekii* the tallest culms are 1.9–9.9(–13.7) cm long vs. (4.5–)6.6–38.0(–51.0) cm long for *C. nigromarginata*. Third, individual plants of *C. reznicekii* have culms often about the same length compared to widely different lengths among individuals of *C. nigromarginata*. Fourth, *C. reznicekii* culms remain erect even at maturity while some culms droop at maturity for *C. nigromarginata*. Fifth, *C. reznicekii* has margins of pistillate scales without red or red only submarginally. The red coloration (if present) can form a submarginal longitudinal stripe, but does not extend laterally to the green (or brown) longitudinal mid-stripe of the scale except at the apex. *Carex nigromarginata* has pistillate scales either similar in color to *C. reznicekii* or more often with dark reddish to dark purplish/black coloration

that extends laterally from the submargin to the green (or brown) mid-stripe of the scale. In addition, the red to purple color often extends all the way to the base of the scale in *C. nigromarginata*, while in *C. reznicekii* the reddish color (if present) does not extend to the base of the scale. Sixth, the apex of the staminate spike in *C. reznicekii* exceeds the apex of the distal-most lateral spike by at most 0.0–3.7 mm. In *C. nigromarginata*, the apex of the staminate spike which exceeds the apex of the distal-most lateral spike the most, exceeds it by (0.0–)0.5–5.1(–7.3) mm. While this character exhibits considerable overlap in these two species, it can sometimes be useful for distinguishing difficult specimens. Seventh, *C. reznicekii* has staminate spikes on average slightly shorter and narrower, measuring 3.3–8.3(–9.2) \times 0.4–1.6(–1.8) mm vs. 4.2–10.9(–12.0) \times 0.5–2.4(–2.8) mm for *C. nigromarginata*. Again this character shows significant overlap, but it occasionally provides useful help in distinguishing between these two species.

Carex reznicekii and *C. nigromarginata* were compared for eight continuous characters (see Table 1). Ranges, means, and standard deviations for all eight continuous characters measured for the NMDS ordination are presented in Table 2. Comparing *C. nigromarginata* and *C. reznicekii*, PC-ORD recommended a two-dimensional solution for the NMDS ordination. This resulted in a final ordination (see Fig. 3) with low instability (<0.001) indicating convergence of the iterations, and low stress (6.61) indicating that the data was far from random and there was “no real risk of drawing false inferences” (McCune & Grace 2002). Axis 1 of the ordination represents decreasing TaCuHe (–0.961) and WiLeWi (–0.747) with the numbers in parentheses representing the Pearson Correlation Coefficients with Axis 1 (Fig. 3). Axis 1 explained 81% of the variability in the dataset. Axis 2 of the ordination represents increasing TaCuHe (0.772), WiLeWi (0.707), StSpExPiSp (0.883), StSpHe (0.899), and StSpWi (0.702) with the numbers in parentheses representing the Pearson Correlation Coefficients with Axis 2 (Fig. 3). Axis 2 explained an additional 17% of the variability for a total of 98% explained variability. Overall, the ordination summarizes a very structured dataset with several highly correlated variables and in addition shows that while the two species are distinct, some overlap of individual specimens exists. Pearson-correlations illustrated that all of the characters measured except width and length of the perigynia were strongly correlated with one another ($p < 0.01$), indicating a high level of redundancy of the characters used. The ordination is presented mainly as a visual tool to show how *C. reznicekii* and *C. nigromarginata* compare with numerous characters.

All of the characters measured except width and length of the perigynia differed significantly between *C. reznicekii* and *C. nigromarginata* (Table 3). The scatter plot graph, using a larger sample size for the two strongest characters separating the two species (tallest culm height and widest leaf width), shows almost all individuals can be determined using these two characters alone (Fig. 4). Ranges, means, and standard deviations for this larger sample size are presented in Table 4. Mainly depauperate or aberrant individuals were not separable with these two characters. These specimens were determined by the additional characters as discussed previously with scale color being the most useful.

Regional differences in the characters were significant only for width and length of perigynia (Table 2). Perigynia of *C. reznicekii* varied by geographical region with slightly narrower and shorter perigynia on plants from the northern region compared to the southern and Missouri/Arkansas regions. These statistically significant differences represent only minor variations and have questionable biological significance.

For the distribution curves for widest leaf width and tallest culm height a total of

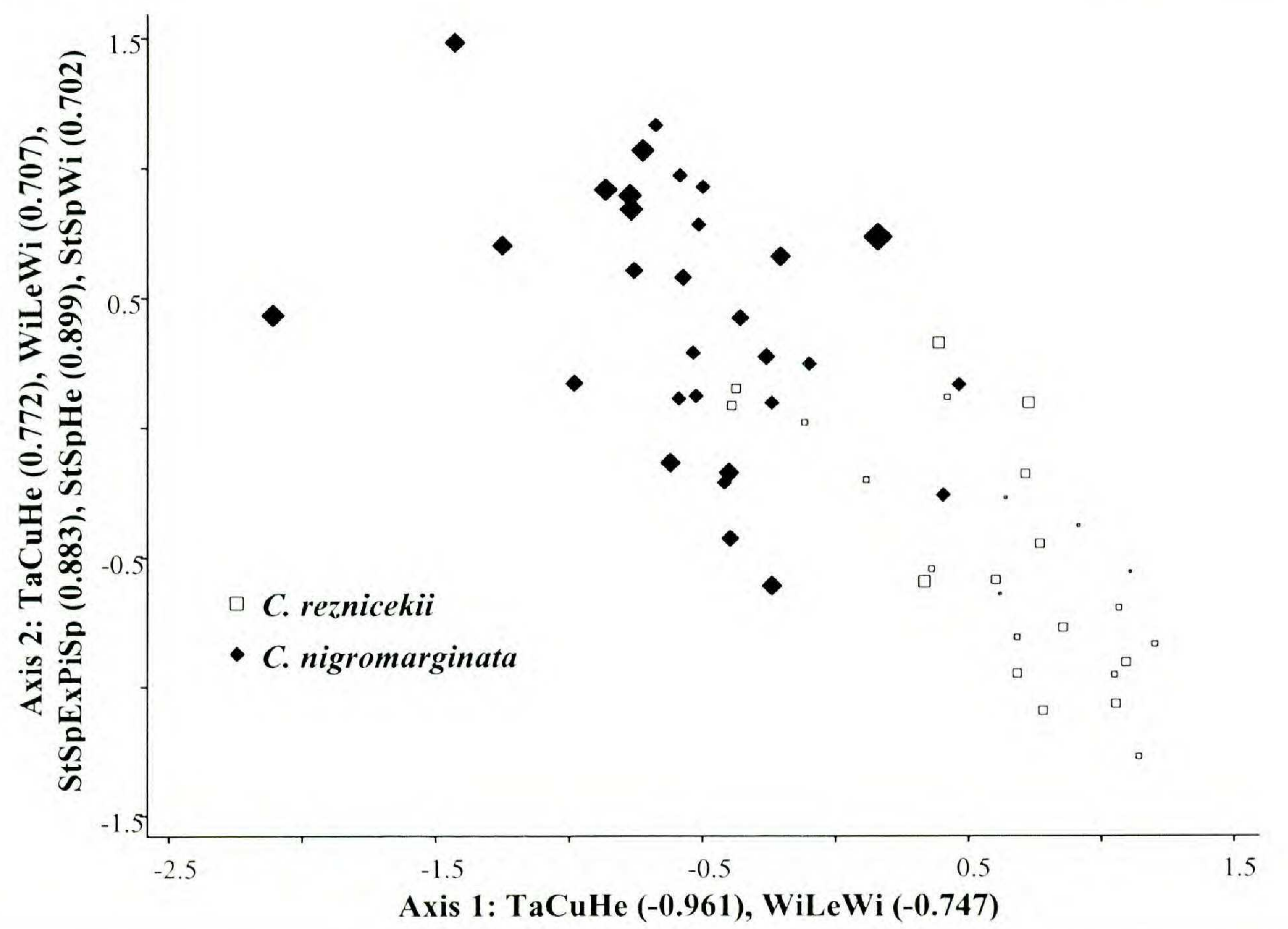


FIG. 3. Non-metric multidimensional scaling ordination showing spatial relationship of *C. reznicekii* and *C. nigromarginata* based on five explanatory characters. Symbols grade larger based on wider widest leaf blade widths. Main characters correlated to each axis are listed with their Pearson Coefficients in parentheses.

TABLE 2. Ranges, means, and standard deviations for characters measured for the NMDS ordination (Fig 3). Character codes are defined in Table 1. Regions listed below are as follows: NE = Virginia/Kentucky north; SE = North Carolina/Tennessee south; and AR/MO = Arkansas/Missouri.

Characters	<i>Carex reznicekii</i> regions				<i>Carex nigromarginata</i> regions			
	NE	SE	AR/MO	All regions	NE	SE	AR/MO	All regions
TaCuLe	2.2–12.2 5.4±3.1	2.5–13.7 5.4±3.3	3.7–13.7 7.3±3.5	2.2–13.7 5.8±3.3	9.0–27.7 15.2±5.2	6.6–18.7 13.3±3.8	7.2–38.0 17.5±8.8	6.6–38.0 15.3±6.3
WiLeWi	1.3–2.2 1.6±0.3	1.3–2.0 1.7±0.3	1.7–2.2 2.0±0.2	1.3–2.2 1.7±0.3	2.4–4.0 2.9±0.5	2.4–3.5 2.7±0.4	2.5–3.5 3.0±0.3	2.4–4.0 2.9±0.4
AnLe	1.30–1.80 1.50±0.15	1.30–1.95 1.52±0.17	1.50–1.75 1.60±0.10	1.30–1.95 1.53±0.15	1.50–2.20 1.82±0.23	1.45–2.25 1.84±0.25	1.60–2.50 1.98±0.30	1.45–2.50 1.88±0.26
StSpExPiSp	0.2–2.5 1.4±0.7	0.2–2.2 1.2±0.5	1.1–3.7 2.5±1.2	0.2–3.7 1.6±0.9	0.7–7.3 3.4±2.0	1.1–6.0 2.7±1.6	0.5–5.5 3.0±1.7	0.5–7.3 3.0±1.7
PeLe	2.75–3.45 3.16±0.21	2.80–3.70 3.23±0.27	3.35–3.55 3.40±0.10	2.75–3.70 3.24±0.23	2.70–3.30 3.14±0.18	2.90–3.60 3.27±0.25	3.00–3.75 3.37±0.25	2.70–3.75 3.26±0.24
PeWi	0.95–1.10 1.02±0.06	1.05–1.20 1.13±0.05	1.05–1.20 1.13±0.07	0.95–1.20 1.09±0.08	0.95–1.35 1.11±0.11	0.90–1.35 1.14±0.12	1.05–1.25 1.12±0.07	0.90–1.35 1.12±0.10
StSpHe	4.60–7.55 6.31±0.89	4.60–7.85 6.05±1.05	5.80–9.00 7.33±1.21	4.60–9.00 6.45±1.11	5.85–12.10 8.41±2.13	6.15–11.15 7.79±1.58	5.35–10.70 8.02±1.74	5.35–12.10 8.07±1.79
StSpWi	0.90–1.55 1.27±0.20	0.70–1.65 1.20±0.28	1.05–1.65 1.31±0.22	0.70–1.65 1.25±0.23	1.05–2.25 1.62±0.36	1.00–2.00 1.50±0.31	1.35–1.75 1.52±0.15	1.00–2.25 1.54±0.28

TABLE 3. Summary of F statistics and probability values from one-way ANOVA between *C. reznicekii* and *C. nigromarginata* for characters measured for ordination.

Characters	F _{1,50}	p
TaCuLe	43.8	<0.001
WiLeWi	136.2	<0.001
AnLe	32.6	<0.001
StSpExPiSp	12.3	0.001
PeLe	0.0	0.914
PeWi	1.6	0.208
StSpHe	13.3	0.001
StSpWi	15.7	<0.000

TABLE 4. Ranges, means, and standard deviations for characters measured for the scatter plot graph and character distribution curves (Fig. 4, 5, and 6).

	<i>C. reznicekii</i> 150 specimens	<i>C. nigromarginata</i> (includes specimens from inside and outside the range of <i>C. reznicekii</i>) 152 specimens	<i>C. nigromarginata</i> outside of range of <i>C. reznicekii</i> 81 specimens
TaCuLe	1.9–13.7 5.3±2.6	4.5–51.0 16.5±7.5	4.5–51.0 19.1±8.0
WiLeWi	1.2–2.5 1.7±0.3	1.9–4.5 2.9±0.5	2.1–4.4 3.0±0.5

TABLE 5. Ranges, means, and standard deviations of particle sizes, pH, and mineral contents of six soil samples.

Measurements		Measurements	
Sand	31–88% 57±20	Mg	33.67–221.09 ppm 136.10±71.84
Silt	9–54% 29±15	Ca	220.28–5509.98 ppm 1732.66±1931.26
Clay	2–27% 14±10	Fe	0.64–45.38 ppm 16.00±20.97
pH	4.35–6.51 5.49±1.02	Al	15.51–317.91 ppm 111.96±117.45
P	0.89–6.40 ppm 2.35±2.06	Mn	20.43–93.99 ppm 69.17±27.38
K	24.76–268.13 ppm 125.79±82.20	Zn	0.87–9.21 ppm 3.54±3.02

150 specimens of *C. reznicekii* and 152 specimens of *C. nigromarginata* were measured. Eighty-one of the *C. nigromarginata* specimens were from outside of the geographic range of *C. reznicekii*. The distribution curves for widest leaf width and tallest culm height for *C. nigromarginata* and *C. reznicekii* combined shows a bimodal distribution of these characters (Fig. 5 and 6). The distribution curves for *C. nigromarginata* and *C. reznicekii* as separate taxa are overlapping normal or skewed normal curves (Fig. 5 and 6). The distribution curves for specimens of *C. nigromarginata* from outside the range of *C. reznicekii* closely mimic the distribution curve for *C. nigromarginata* throughout its range and also clearly contrasts with the distribution curves of *C. reznicekii* (Fig. 5 and 6). These distri-

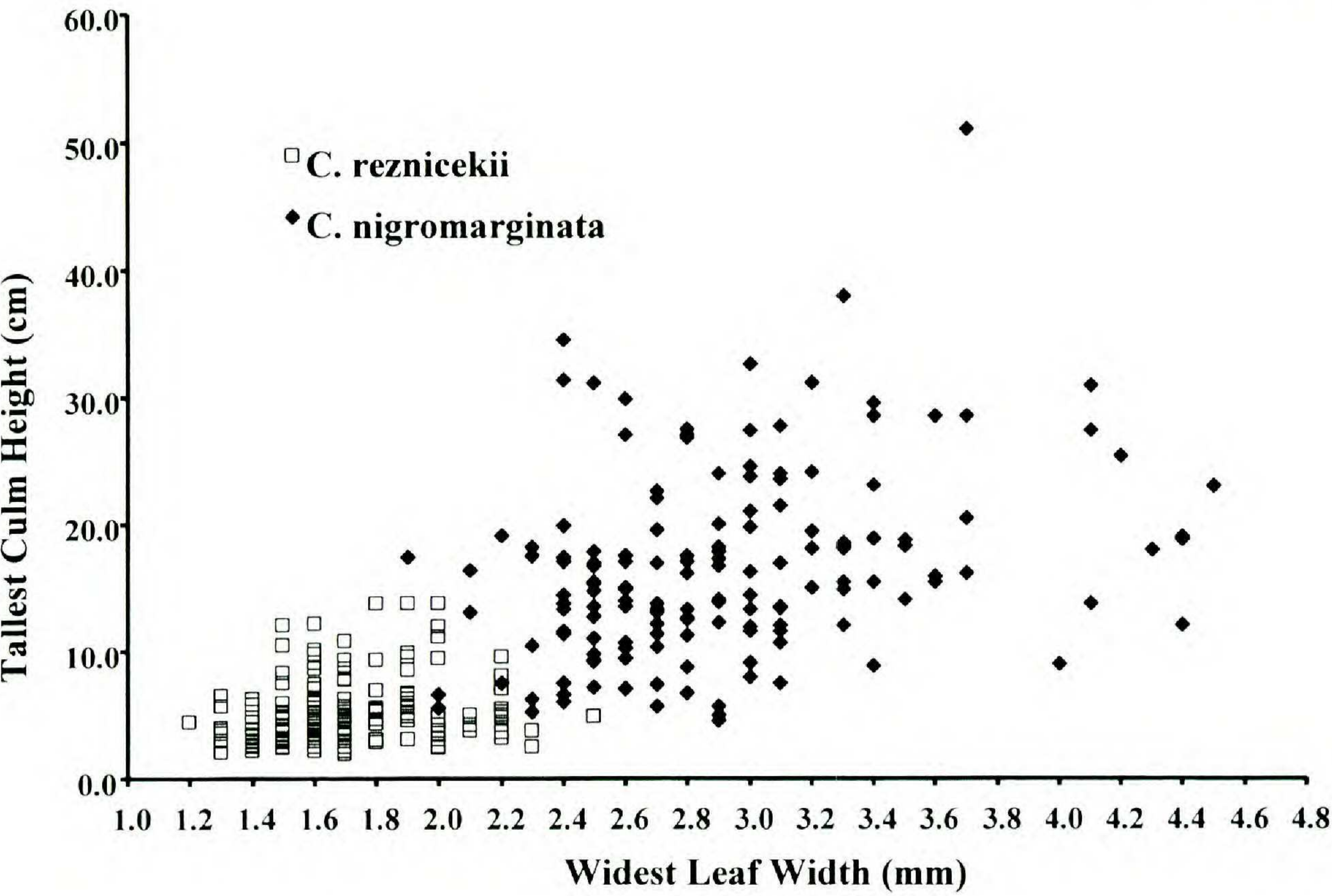


FIG. 4. Scatter plot of all specimens examined for widest leaf width by tallest culm height for *C. nigromarginata* and *C. reznicekii*.

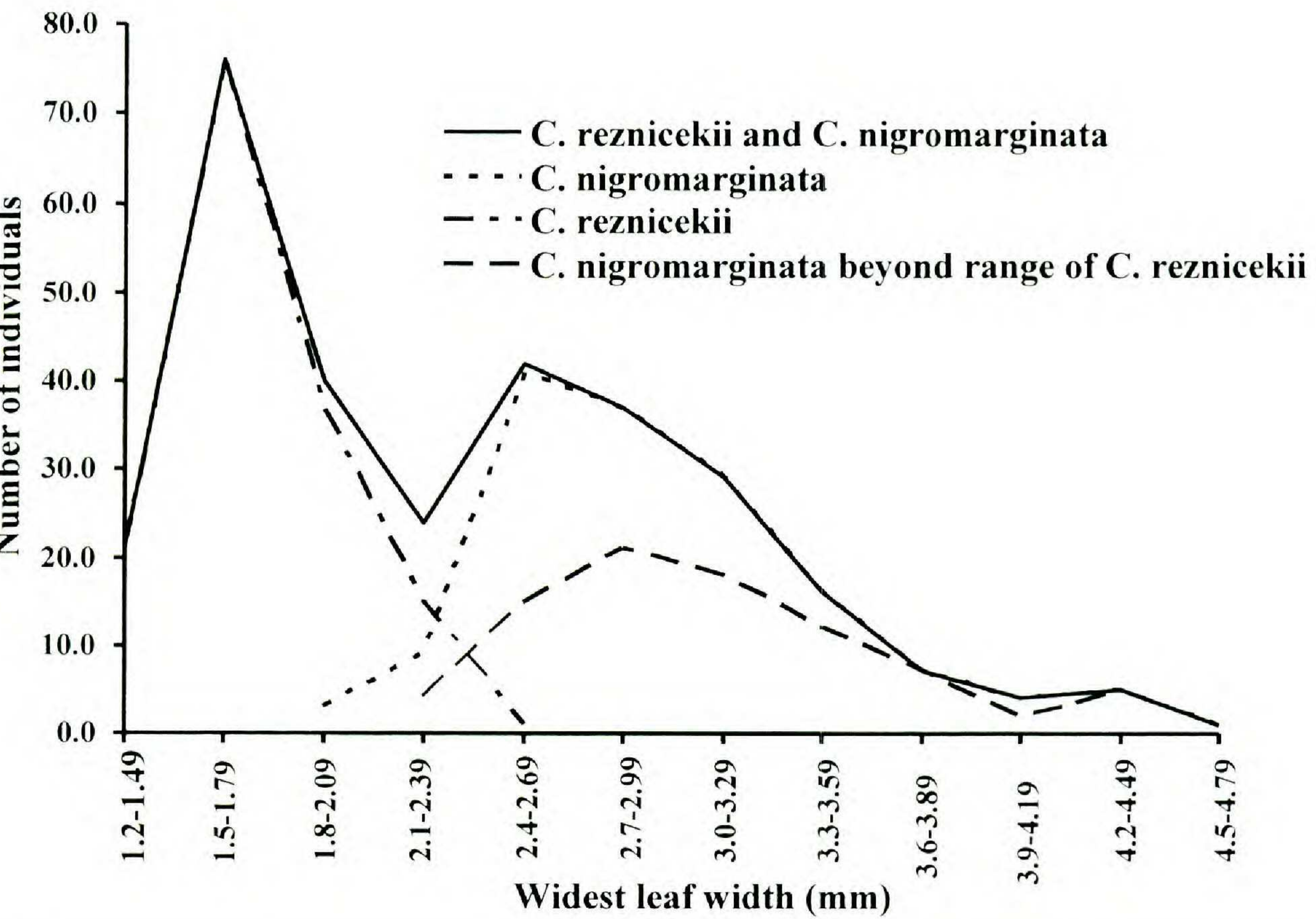


FIG. 5. Distribution curves for widest leaf width for *C. reznicekii*, *C. nigromarginata*, *C. reznicekii* and *C. nigromarginata* combined, and *C. nigromarginata* specimens outside the geographic range of *C. reznicekii*.

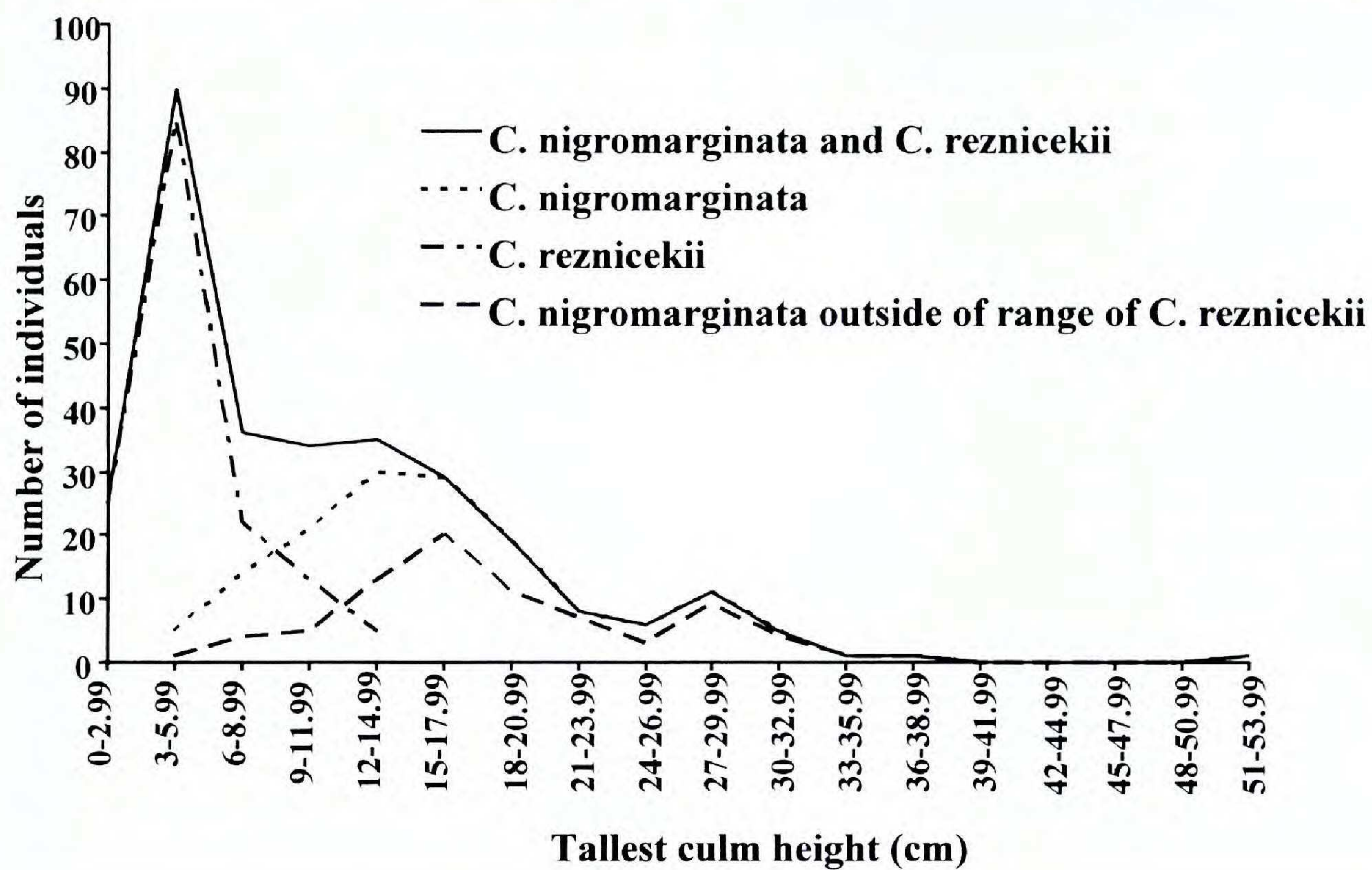


FIG. 6. Distribution curves for tallest culm height for *C. reznicekii*, *C. nigromarginata*, *C. reznicekii* and *C. nigromarginata* combined, and *C. nigromarginata* specimens outside the geographic range of *C. reznicekii*.

bution curves help to demonstrate that although there is some overlap in the two most explanatory characters that separate *C. nigromarginata* and *C. reznicekii*, the distinction between these two species is not a result of a sampling bias. The two species simply have slightly overlapping normal or skewed normal distribution curves.

Geography

Carex reznicekii occurs from New England (southern Rhode Island and southern Connecticut) south to southeastern New York, eastern Pennsylvania, South Carolina, and Georgia west to southern Missouri and northern Arkansas (Fig. 1). It is quite common in the southeastern US.

The range of *C. reznicekii* appears to be totally within the range of *C. nigromarginata* and *C. umbellata* (Crins & Rettig 2002). The distribution of *C. nigromarginata* extends beyond the range of *C. reznicekii* into southern Ontario, central and western Pennsylvania, southern Ohio, Indiana, Illinois, central Missouri, central and southern Arkansas, Oklahoma, Texas, Louisiana, southern Mississippi, southwestern Alabama, and the panhandle of Florida (specimens examined, Reznicek & Catling 1982; Cusick 1992; Crins & Rettig 2002). The distribution of *C. umbellata* extends well beyond the range of *C. reznicekii* into Greenland, eastern and western Canada, and from Nebraska south to Texas (Crins & Rettig 2002).

Ecology

Carex reznicekii occupies mesic to dry-mesic mostly deciduous or less commonly deciduous-pine and/or *Ilex opaca* Aiton forests. Overstory tree canopy cover often exceeds ca. 60% but does not create dense shade. The shrub layer is usually not very dense. The herb layer varies from quite diverse to not diverse, and quite dense to not dense. Occa-

sionally *C. reznicekii* grows in clearings in forests. Even at these sites, it is mostly found in the adjacent full-canopy forests. It also occurs along road edges immediately adjacent to forests as well as in the forest interior. Overall, it grows predominately in full-canopy forests, and unlike some other members of section *Acrocystis* (e.g., *C. nigromarginata* and *C. umbellata*), it usually does not do equally as well in more open environments.

Carex reznicekii often occurs on slopes above drainages from the bases of the slopes to mid-slopes and occasionally on the upper slopes or crests. It usually does not occur in the actual floodplain of the adjacent drainage unless the drainage is relatively small. Additionally, *C. reznicekii* usually does not occur on upper slopes, especially if ericaceous shrubs and *Quercus montana* Willd. are dominant.

Many members of *Carex* section *Acrocystis* in eastern North America often grow together. Perhaps this is because they grow in a “generalized” habitat (Cusick 1992). Other members of section *Acrocystis* observed growing syntopically with *C. reznicekii*, often within centimeters of it, include *C. albicans* var. *albicans*, *C. albicans* var. *emmonsii*, *C. nigromarginata*, *C. pensylvanica* Lamareck, *C. tonsa* var. *tonsa*, *C. tonsa* var. *rugosperma*, and *C. umbellata*. *Carex nigromarginata* occurred as the most frequent associate, being found with *C. reznicekii* at 19 out of the 31 sites visited. Despite *C. nigromarginata* frequently growing syntopically with *C. reznicekii*, some habitat differences between the two were observed. *Carex reznicekii* usually grew without or with low densities of *C. nigromarginata* in more calcareous or richer sites as well as lower on slopes. *Carex reznicekii* usually did not occur or occurred in lower densities with *C. nigromarginata* at more acidic sites, higher up on slopes, or in more open disturbed habitats.

Soils are deep or less frequently shallow over bedrock. Bedrock present at sites includes diabase, limestone, shale, and sandstone. Soil samples showed a wide variety of soil textures ranging from sandy to sandy loam to silty loam to sandy clay loam to clay loam. Table 5 summarizes the ranges, means, and standard deviations of values for particle size, pH, and mineral content of the six soil samples.

IDENTIFICATION KEY FOR MEMBERS OF CAREX SECTION ACROCYSTIS
EAST OF THE ROCKY MOUNTAINS OF NORTH AMERICA

This key works best with ample specimens in mature fruit. Depauperate or especially robust specimens may not key correctly. Rhizomes help in identification, but collectors often fail to collect them. The key attempts, where possible, to get around relying on rhizome characters. Parts of the key dealing with *C. communis* varieties and *C. inops* ssp. *heliophila* are adapted from Crins and Rettig (2002).

1. Culms with some pistillate spikes elongate-pedunculate arising from near base of culms (sometimes difficult to assess because peduncles can be hidden by sheathes of bracts and leaves until they emerge adjacent to distal half of culms); pistillate spikes arising from distal half of culms mostly 0–3.
2. Pistillate scales from slightly shorter to longer than the perigynia; terminal staminate spikes with or without approximate pistillate spikes; bracts at base of proximal-most non-basal pistillate spikes (if present) mostly shorter than to sometimes slightly longer than inflorescences; bases of old leaves often very fibrous.
3. Perigynia (2.2–)2.3–3.2(–3.3) mm long, beaks (0.4–)0.5–1.0 mm long _____ **Carex umbellata**
3. Perigynia (3.0–)3.1–4.7 mm long, beaks 0.9–2.1 mm long.
4. Perigynia often mostly glabrous; young leaves short, thick, often smooth adaxially, and rigid _____ **Carex tonsa** var. **tonsa**
4. Perigynia usually pubescent; young leaves long, thin, scabrous adaxially, and not rigid _____ **Carex tonsa** var. **rugosperma**

- 2. Many pistillate scales shorter than mature perigynia; terminal staminate spikes almost always with at least one approximate pistillate spike; bracts at base of proximal-most non-basal pistillate spikes mostly longer than inflorescences; bases of old leaves not or only slightly fibrous.
- 5. Perigynia (2.2–)2.6–3.1(–3.2) mm long, beaks 0.4–0.8 mm long, beak teeth up to 0.2 mm long; pistillate scales often shorter than the body of mature perigynia; staminate spike 3.5–5.9(–6.7) mm long; rhizomes slender; plants loosely caespitose _____ **Carex deflexa** Hornem. var. **deflexa**
- 5. Perigynia 3.1–4.2 mm long, beaks 0.9–1.7 mm long, beak teeth 0.2–0.5 mm long; pistillate scales often longer than the body of mature perigynia; staminate spikes 4.2–11.6 mm long; rhizomes stout; plants densely caespitose _____ **Carex rossii** Boott
- 1. Culms with pistillate spikes short-pedunculate to sessile (proximal-most non-basal spikes occasionally elongate-pedunculate) and arising from distal half of culms [occasional culms will have one pistillate spike with an elongate peduncle arising from base of culms (these may represent hybrids)]; pistillate spikes arising from distal half of culms mostly 2–4.
- 6. Longest staminate spike at least 12.3 mm long (use ample specimens); rhizomes elongated (except *C. albicans* var. *albicans*, *C. communis*, and *C. novae-angliae*: these key out in either lead of 6); perigynia bodies globose to ellipsoid, as long as or longer than wide.
- 7. Widest perigynium equal to or less than 1.2 mm wide; widest leaf blades 1.1–2.7 mm wide; perigynia bodies ellipsoid, longer than wide.
- 8. Widest leaf blades 1.1–1.8 mm wide; proximal internode of inflorescence 5.2–29(–40) mm long; staminate spike peduncles 1.2–8.0(–8.6) mm long; proximal-most pistillate spike peduncles 0.8–9.8 mm long; spike above the proximal-most spike subtended by a bract which often has an elongate awn; pistillate scales not red, sometimes with some red-brown _____ **Carex novae-angliae** Schwein.
- 8. Widest leaf blades 1.3–2.7 mm wide; proximal internode of inflorescence 1.0–13.2(–20.1) mm long; staminate spike peduncles 0.3–4.5(–8.8) mm long; proximal-most pistillate spike peduncles 0.3–2.2(–3.3) mm long; spike above the proximal-most spike subtended by a bract which usually has at most a short awn; pistillate scales sometimes partly red.
- 9. Rhizomes elongate and spreading _____ **Carex albicans** var. **australis** (Bailey) Rettig
- 9. Rhizomes short and ascending to erect _____ **Carex albicans** var. **albicans**
- 7. Widest perigynium greater than 1.2 mm wide; widest leaf blades 1.5–6.1 mm wide; perigynia bodies often globose to broadly ellipsoid, about as long as wide to slightly longer than wide.
- 10. Widest leaves (2.3–)3.0–6.1 mm wide; plants with large caespitose clumps; not colonial; rhizomes short and ascending to erect; bracts subtending the spike above the proximal-most with an elongate awn tip that arises from scarious margins that are truncate to convex at summit; staminate spikes 0.9–2.2(–2.5) mm wide.
- 11. Perigynia beak teeth 0.1–0.2(–0.3) mm long; pistillate scales usually 1.6 mm wide or less; widespread _____ **Carex communis** var. **communis**
- 11. Perigynia beak teeth usually more than 0.2 mm long; pistillate scales usually more than 1.6 mm wide; Georgia and South Carolina _____ **Carex communis** var. **amplisquama** (Hermann) Rettig
- 10. Widest leaves less than 3.0(–3.5) mm wide; plants with small caespitose clumps; colonial; rhizomes spreading and long; bracts subtending the spike above the proximal-most with a short or no awn tip that arises from scarious margins that mostly taper into the distal part of the bract; staminate spikes (1.1–)1.5–3.2(–5.2) mm wide.
- 12. Perigynia 1.1–1.6(–1.8) mm wide.
- 13. Perigynia beaks 0.3–0.8(–0.9) mm long, beak/body ratio 0.13–0.50(–0.56) _____ **Carex pensylvanica**
- 13. Perigynia beaks 0.9–1.6 mm long, beak/body ratio 0.50–0.92.
- 14. Widest leaf blades greater than (1.7–)2.0 mm wide; northeastern North America _____ **Carex lucorum** Willd. ex Link var. **lucorum**
- 14. Widest leaf blades less than 2.0 mm wide; southern Appalachian Mountains _____ **Carex lucorum** var. **australucorum** Rettig

12. Perigynia (1.6–)1.7–2.2 mm wide _____ **Carex inops** ssp. **heliophila**
6. Longest staminate spike less than 12.3 mm long (use ample specimens); rhizomes not elongate (except *C. floridana* and *C. albicans* var. *australis*: the latter keys out in either lead of 6); perigynia bodies ellipsoid, longer than wide (except *C. deflexa* and *C. communis*: the latter keys out in either lead of 6).
15. Pistillate scales shorter than body of mature perigynia they subtend.
16. Proximal internode of inflorescence 5.2–29(–40) mm long; staminate spikes (4.6–) 5.1–12.1 mm long _____ **Carex novae-angliae**
16. Proximal internode of inflorescence 1.3–8.5(–14.5) mm long; staminate spikes 3.5–8.3(–9.2) mm long.
17. Culms mostly surpassed by leaves; perigynia (2.2–)2.6–3.1(–3.2) mm long _____ **Carex deflexa** var. **deflexa**
17. Culms surpassing leaves; perigynia (3.0–)3.1–4.2 mm long _____ **Carex peckii** Howe
15. Pistillate scales longer than body of mature perigynia they subtend.
18. Widest leaf blades (2.3–)3.0–6.1 mm wide; proximal internode of the inflorescence (5.9–)7.5–36.0 mm long; bract subtending the spike above the proximal-most with an elongate awn tip that arises from scarious margins that are truncate to convex at summit; perigynia bodies globose to broadly ellipsoid, about as long to slightly longer than wide.
19. Perigynia beak teeth 0.1–0.2(–0.3) mm long; pistillate scales usually 1.6 mm wide or less; widespread _____ **Carex communis** var. **communis**
19. Perigynia beak teeth usually more than 0.2 mm long; pistillate scales usually more than 1.6 mm wide; Georgia and South Carolina _____ **Carex communis** var. **amplisquama**
18. Widest leaf blades 1.1–4.5 mm wide (if widest leaves are over 2.7 mm wide then proximal internode of the inflorescence 0.8–5.4 (8.0) mm long); bract subtending the spike above the proximal-most with or without an elongate awn tip that arises from scarious margins that mostly taper into the distal part of the bract (occasionally truncate to convex at summit); perigynia bodies ellipsoid, longer than wide.
20. Widest leaf blades 1.1–1.8 mm wide; proximal internode of inflorescence 5.2–29(–40) mm long; staminate spike peduncles 1.2–8.0(–8.6) mm long; proximal-most pistillate spike peduncles 0.8–9.8 mm long; spike above the proximal-most spike subtended by a bract which often has an elongate awn; pistillate scales without true red, sometimes with some red-brown _____ **Carex novae-angliae**
20. Widest leaf blades 1.2–4.5 mm wide; proximal internode of inflorescence 0.8–13.2(–20.1) mm long; staminate spike peduncles 0.1–4.5(–8.8) mm long; proximal-most pistillate spike peduncles 0.0–2.2(–3.3) mm long; spike above the proximal-most spike subtended by a bract which usually has at most a short awn; pistillate scales sometimes with some red.
21. Longest leaf blades up to 2.2(–2.7) times as long as the median culm length; perigynia 2.2–3.2(–3.3) mm long; proximal internode of inflorescence 1.0–13.2(–20.1) mm long; staminate spike peduncles 0.3–4.5(–8.8) mm long.
22. Rhizomes elongate and spreading _____ **Carex albicans** var. **australis**
22. Rhizomes short and ascending to erect.
23. Staminate spikes (5.5–)6.6–12.2(–14.5) mm long; middle and upper staminate scales mostly with midrib faint, not raised, not scabrous towards tip of scale, and mostly without a minute awn arising just below tip of scale _____ **Carex albicans** var. **albicans**
23. Staminate spikes 4.0–8.7(–9.3) mm long; middle and upper staminate scales mostly with midrib more prominent, raised, antrorsely scabrous towards tip of scale, and with a minute awn arising from just below tip of scale _____ **Carex albicans** var. **emmonsii**
21. Longest leaf blades at least (2.3–)2.5 times as long as the median culm length; perigynia (2.5–)2.7–4.0 mm long; proximal internode of inflorescence 0.8–5.4(–8.0) mm long; staminate spike peduncles 0.1–0.8(–1.6) mm long.
24. Rhizomes horizontally spreading to ascending and elongate; mostly at

least some stigmas 2; mostly at least some achenes with only 2 pale nerves; sheathes of old leaves at base of plant usually weakly fibrous

Carex floridana

24. Rhizomes ascending to erect and short; stigmas 3; achenes with 3 pale nerves; sheathes of old leaves at base of plant often strongly fibrous.

25. Widest leaf blades 1.2–2.2(–2.5) mm wide; culms often about equal length, the longest 1.9–9.9(–13.7) cm long; any reddish color on pistillate scales below the distal tip not extending laterally from near the margin to the green or brown longitudinal mid-stripe on either side of mid-vein; the longest staminate spike up to 3.7 mm taller than the distal most lateral spike apex; staminate spikes 3.3–8.3(9.2) mm long \times 0.4–1.6(–1.8) mm wide

Carex reznicekii

25. Widest leaf blades (1.9–)2.3–4.5 mm wide; culms often of quite variable length, the longest (4.5–)6.6–38.0(–51.0) cm long; at least some pistillate scales often with reddish to purplish/black color below the distal tip extending laterally from near the margin to the green or brown longitudinal mid-stripe on either side of mid-vein; the longest staminate spike (0.0–)0.5–5.1(–7.3) mm taller than the distal most lateral spike apex; staminate spikes 4.2–10.9(–12.0) mm long \times 0.5 2.4(–2.8) mm wide

Carex nigromarginata

Representative specimens of *Carex reznicekii*: Specimens marked with a single asterisk were measured for the ordination (Fig. 3); the ones marked with a single or double asterisk were measured for the scatter plot graph and character distribution curves (Fig. 4, 5, and 6).

U.S.A. ALABAMA. Dekalb Co.: near top of Red Mountain, just NW of Fort Payne, 21 Apr 1943, *Harper* 3918 (MO, US*), *Harper* 3919 (BH**, GH, US). **Houston Co.:** vicinity of Columbia, Thomas Creek up to bluff along Ommussee Creek, 12 Mar 1998, *MacDonald* 10970 (BRIT**). **Jackson Co.:** ca. 3 mi W of Carns, along E side of county Route 33, 22 Apr 2002, *Naczi* 9034 (DOV**); just E of Route 35, 0.1 mi S of junction with Route 40, 21 Apr 2004, *Werier* 2075 (BH*); county Route 33, 8.05 mi by road SE of junction with Route 79, 21 Apr 2004, *Werier* 2081 (BH**, MICH, NCU). **Limestone Co.:** by I-65, ca. 5 mi N of US 31 turnoff to Athens, 26 Mar 1986, *Kral* 73127 (BRIT**). **Morgan Co.:** by US 31, 1 mi S of Lacon, 12 Apr 1970, *Kral* 38342 (BRIT**). **Tuscaloosa Co.:** by AL 69, 9 mi N of Moundville, 1 Apr 1984, *Kral* 71138 (BRIT**). **ARKANSAS. Baxter Co.:** Cole Fork along Cripple Turkey Road, 26 Apr 1993, *Hyatt* 5243 (MICH*). **Independence Co.:** 6.95 mi S of Sharp Co. Line (in Cave City) on US Hwy. 167, 9 Apr 1994, *Hyatt* 5838 (MICH*), *Hyatt* 5839 (MICH*). **Izard Co.:** ca. 0.5 mi SE of Baxter Co. on AR Hwy. 5, 18 Mar 1998, *Hyatt* 7879 (MICH**). **Johnson Co.:** [Ozark National Forest], Horsehead Lake Recreation Area, western most picnic area, 12 Apr 1996, *Hyatt* 6896 (MICH*). **Marion Co.:** Buffalo National River, 100–200 m NE of Buffalo River Bridge of state Hwy. 14, 10 Apr 1994, *Hyatt* 5844 (MICH*). **Newton Co.:** S of Harrison, 0.8 mi N of Harp Creek, along Hwy. 7, 14 Apr 1984, *Castaner* 7992 (DOV**). **Stone Co.:** Mountain View vicinity, about 10 mi SSE on AR Hwy. 5, 8.5 mi N of Cleburne Co. line, 18 Mar 1998, *Hyatt* 7886 (MICH**). **CONNECTICUT. New Haven Co.:** City of New Haven, West Rock Ridge, a little N of “Judges Cave,” 20 May 2005, *Werier* 2533 & *Haines* (BH**). **DELAWARE. Kent Co.:** above Choptank River floodplain at Sandtown landfill, N of Sandtown, 30 Apr 2003, *McAvoy* 5742 (DOV*). **[New Castle Co.]:** Mount Cuba, 1 May 1898, *Bicknell* 3255 (NY*); near Centreville, 28 Apr 1876, *Commons* s.n. (PH**). **Sussex Co.:** 3 mi E of Milford, along S side of Beaverdam Branch, ca. 0.2 mi W of its crossing by road 200, 21 Apr 2003, *Naczi* 9521 (BRIT, DOV**). **[Sussex Co.]:** Laurel, 25 Apr 1882, *Smith* 717 (US**). **[DISTRICT OF COLUMBIA]. [Washington Co.]:** Washington, 25 Apr 1897, *Steele* s.n. (GH**); District of Columbia and vicinity, 7 May 1899, *Williams* s.n. (NY**); Anacostia to Twining City, 7 Apr 1918, *Leonard* 139a (US**). **GEORGIA. Clarke Co.:** E of Athens, end of Rock and Shoals Road off Barnett Shoals Road, 24 Feb 1981, *Manhart* 202 (BRIT**, MICH**, MO, NYS). **Clay Co.:** 1 mi E of Fort Gaines, 27 Mar 1949, *Thorne & Muenscher* 9312 (GH**). **Dade Co.:** Sitton’s Gulch, Lookout Mountain, 2 mi SE, Trenton, 17 Mar 1939, *Hermann* 10192 (GH*, NY**). **Hall Co.:** Chipowee Woods (Elachee Preserve), 19 Mar 2005, *Hyatt* 11802 (BH**), 9 Apr 2005, *Hyatt* 11807 (BH**). **Randolph Co.:** near Griers Cave, N of Cuthbert, 3 Apr 1948, *Thorne & Muenscher* 7910 (BH**). **Walker Co.:** W side of GA Route 136, 1.6 mi by road W of GA Route 193, 0.4 mi W of Cooper Heights Community, 8 Apr 2000, *Hill* 32220 (NY); just W of Route 136, 1.6 mi by road W of junction with Route 193, 20 Apr 2004, *Werier* 2069 (BH*, MICH, NCU). **KENTUCKY. Butler Co.:** Roundabout Swamp, at end of Biggerstaff Road, off Hwy. 1153, 22 Apr 1993, *McKinney* 5360 (MICH*). **Edmonson Co.:** Mammoth Cave National Park, Ugly Creek S from junction with Little Jordon Cemetery Road, 23 Apr 1991, *McKinney & Evans* 4622 (BRIT**). **Rowan Co.:** Lick Fork, 4 Apr 1938, *Braun* 1758 (US**). **MARYLAND. Caroline Co.:** Tuckahoe State Park, off Cherry Lane, approximately 1.2 mi S of junction with Mason Branch Road,

14 Apr 1997, *Frye* 779 (MICH**), 2 May 2004, *Werier* 2176 (BH*), *Werier* 2178 (BH**, MICH, US); Tuckahoe State Park, entrance to Cherry Lane picnic area., 2 May 2004, *Werier* 2181 (BH**, MICH, US). **Cecil Co.:** along Bohemia Creek, Middle Neck, 7 May 1932, *Long* 37288 (PH**). **Dorchester Co.:** N side of Puckum Branch, W of Puckum Road, N of Eldorado, 15 May 2003, *McAvoy* 5797, *Elliott, & Elliott* (DOV*). **Kent Co.:** above the "Big Marsh," W of Betterton, 27 Apr 2003, *McAvoy* 5739 (DOV**). **Montgomery Co.:** Plummer's Island in the Potomac River, near Cabin John, 10 May 1915, *Van Eseltine* 325 (BH**). **Wicomico Co.:** S side of Bear Swamp Road, SW of Powellville, 18 Apr 1999, *McAvoy* 4268 (DOV**). **MISSISSIPPI. Lafayette Co.:** NE of Oxford, 5.4 mi NE of junction of MS 7 and 30 on MS 30 then ca. 1 mi S on Hopewell Road, 12 Apr 1997, *Bryson* 15732 (BRIT, DOV**). **Lowndes Co.:** 2.5 mi N of Steens, N side of Vaughn Robertson Road, 20 Apr. 1986, *Bryson* 4217 & *Curtis* (MICH, MO), 12 Apr 1987, *Bryson* 5341 (MICH**). **MISSOURI. Shannon Co.:** above intermittent tributary of E branch of Dennis Hollow, 13 May 1997, *Brant* 3696 (MO**); Rocky Creek Falls, 24 Apr 1983, *Merriott* 61 (MICH*). **NEW JERSEY. Burlington Co.:** Bordentown, along Crosswicks Creek, 27 Apr 1910, *Long* 3103 (NY**). **[Gloucester Co.]:** Swedesboro, 25 Apr 1917, *Mackenzie* 7559 (NY**). **Sussex Co.:** Andover Township, SW of Lake Mohawk, just N of Route 613, 0.5 mi by road W of junction with Route 617, 4 May 2004, *Werier* 2191 (BH**, MICH, NY); Stokes State Park, S of county Route 636, 0.25 mi E of US Route 206, 4 May 2004, *Werier* 2194 (BH*, MICH, NY). **[Warren Co.]:** between Pike and Pequest River ca. 1/4 to 3/8 mi E by slightly NE of Buttsville, 18 May 1919, *Pretz* 9602 (PH**). **NEW YORK. New York Co.:** Manhattan Island, Inwood, 27 May 1893, *Bicknell* 1237 (NY**). **Orange Co.:** Town of Warwick, SE end of Bellvale Mountain, N of the village of Greenwood Lake, SW of Route 17A, 7 May 2003, *Werier* 1507 & *Barbour* (BH*). **Ulster Co.:** Town of Saugerties, 1.0 km E of Old Dutch Road, 1.1 mi S by road from Route 32, 22 May 2006, *Werier* 2981, *Barbour & Barbour* (BH). **NORTH CAROLINA. Davidson Co.:** 1 mi E of Yadkin River near NC 49, 7 Apr 1956, *Radford* 9476 (NCU**); S of Route 49, 0.6 mi E of bridge over Yadkin River, 14 Apr 2004, *Werier* 1995 (BH*, MICH), *Werier* 2000 (BH**, MICH, NCU), *Werier* 2001 (BH**, MICH). **Macon Co.:** Nantahala National Forest, ca. 5 mi E of Franklin, then 5 mi N of Ellijay Road, 16 Apr 2000, *Hyatt, Hyatt, & McMillan* 9112 (MICH**); W of Ellijay Road and Ellijay Creek, 3.7 mi by road NE from Route 64, 19 Apr 2004, *Werier* 2048 (BH*, MICH, NCU); E of Route 2, 5.4 mi by road NE from Route 64, 19 Apr 2004, *Werier* 2052 (BH**, DOV, MICH). **Madison Co.:** 0.5 mi WNW of Marshall on NE side of French Broad River, 26 Apr 1958, *Ahles* 38966 & *Duke* (NCU**). **Mecklenberg Co.:** 2.4 mi SE of Davidson on NC 73, 22 Apr 1958, *Ahles* 38691 & *Britt* (NCU**). **Orange Co.:** Phills Creek, N side, 3 mi W of Chapel Hill, 18 Apr 1940, *Radford & Stewart* 469a (NCU**). **Swain Co.:** Nantahala National Forest, Wessen vicinity, S side of US Hwy. 19, 10 Apr 2000, *Hyatt* 9071 (MICH**). **PENNSYLVANIA. Berks Co.:** 5/8 mi ENE of Walnut & 14th Street, Reading, 20 May 1943, *Berkheimer* 3563 (NYS*). **[Lancaster Co.]:** Lancaster, [no date], [no collector] s.n. (MICH**); [no location information], [no date], [*Muhlenberg?*] s.n. (PH**); [no location information], [no date], *Muhlenberg* s.n. (PH**). **RHODE ISLAND. [Washington Co.]:** South Kingston, 13 May 1877, *Congdon* 1776 (NY**). **SOUTH CAROLINA. Chester Co.:** near Catawba River at Great Falls, 15 Apr 1961, *Radford* 43511 (NCU**). **Chesterfield Co.:** W of Catarrh, just E of Lynches River, and just S of Route 903, 17 Apr 2004, *Werier* 2013 (BH*, MICH). **Fairfield Co.:** 2 mi NE of Altston, 15 Apr 1961, *Radford* 43473 (NCU**). **Greenville Co.:** E of Marietta, small road, 20 m SE from Route 414, 2.1 mi by road NE from Route 276, 18 Apr 2004, *Werier* 2029 (BH**, MICH). **Horry Co.:** 2 mi S of Myrtle Beach, 18 Apr 1932, *Weatherby & Griscom* 16461 (PH**, US**). **Lancaster Co.:** near Catawba River, 2 mi NE of Great Falls, 15 Apr 1961, *Radford* 43524 (NCU**); E of Great Falls and a little bit E of the Catawba River, 17 Apr 2004, *Werier* 2023 (BH**, MICH), *Werier* 2027 (BH**); E of US 601, S side of Flat Creek, 21 Apr 1961, *Williamson* F138 & *Ahles* (NCU**), 16 Apr 2004, *Werier* 2010 (BH*, MICH). **Pickens Co.:** SC Department of Natural Resources eastern tract of Lake Jocassee, S of Mill Creek entrance, 19 May 1998, *Waldrop* W-274 & *Townsend* (MICH**); just E of tributary to Oolenoy River and SSR 69, 0.1 mi by road N from Route 288, 2.5 mi by road E from Route 178, 18 Apr 2004, *Werier* 2038 (BH**, MICH), *Werier* 2041 (BH**, DOV NCU). **TENNESSEE. Franklin Co.:** 2.6 road mi S of Huntland, along E side of Route 97, 2.6 road mi S of junction of Routes 97 and 122, 24 May 1998, *Naczi* 7249 & *Ford* (VPI**). **Grundy Co.:** just NW of state Route 50 (Elk Head Rd.), 5.7 mi by road SW from junction with Route 108, 22 Apr 2004, *Werier* 2087 (BH*, MICH); E of Route 56 at hair pin turn, 6.6 mi by road S from Warren Co. line, 22 Apr 2004, *Werier* 2098 (BH**, MICH). **Jackson Co.:** W side of the Cumberland River at its junction with Cub Creek, 19 Apr 1998, *Phillippe* 29579 (MICH**); NE of Cub Creek just before junction with Cumberland River, 23 Apr 2004, *Werier* 2102 (BH**, MICH). **[Jefferson Co.]:** French Broad River, near Dandridge, 1844, *Rugel* s.n. (MO**, NY**). **[Knox Co.]:** Knoxville, Cherokee Bluffs, 9 Apr 1930, *Underwood* 5 (GH**). **Marion Co.:** S end of Little Cedar Mountain, W side of Nickajack Lake, and 2.8 km N of Interstate 24 bridge W of Haletown, 8 Apr 2000, *Wieboldt* 10418 (MICH**, VPI); E slope of Little Cedar Mountain, ca. 3.5 km N of interstate 24 bridge over Nickajack Lake, NNW of Haletown, 8 Apr 2000, *Wieboldt* 10423 (MICH**, VPI). **Maury Co.:** bluffs of Duck River ca. 2.5 mi SE of Columbia and 1.2 mi E on Sowell Pike from TN 50, 13 Apr 1974, *Kral* 42463 (BRIT**, MO). **Polk Co.:** N of Ocoee Lake and Route 64, 1.7 mi W of junction with Route 314, 20 Apr 2004, *Werier* 2062 (BH*), 20 Apr 2004, *Werier* 2063 (BH**, MICH). **Putnam Co.:** bluffs along Caney Fork River by I-40, 10 Apr 1992, *Kral* 80112

& Moore (BRIT**). **Rutherford Co.:** just N of Luvergne, 9 Apr 1976, Kral 57547 (BRIT**, MO). **Sevier Co.:** N of Little Cove Creek Road, 4.8 mi by road E of Wear Valley Road, 27 Apr 2004, Werier 2132 (BH**, MICH). **VIRGINIA.** **Accomack Co.:** S side of road to Sinnickson, 18 Apr 1999, McAvoy 4266 (DOV**). **Albemarle Co.:** Mount Alto, near Howardsville, 21 Apr 1973, Stevens 6523 (NCU**), 21 Apr 1973, Stevens 6525 (NCU**). [**Albemarle Co.:** Monticello Mountain, the Grove, 21 Apr 1980, Wieboldt M-26 (PH**). **Alleghany Co.:** N of Route 18, N of small creek which is a tributary of Potts Creek, 0.6 mi by road S from Route 657, 30 Apr 2004, Werier 2153 (BH**, DOV, MICH, VPI), 30 Apr 2004, Werier 2155 (BH**); 30 Apr 2004, Werier 2156 (BH**, MICH, VPI). **Botetourt Co.:** NW of Route 615, 0.7 mi by road N of junction with Craig Co. line, 29 Apr 2004, Werier 2143 (BH**, MICH, MO, NCU, VPI), 29 Apr 2004, Werier 2146 (BH**). **Brunswick Co.:** along Hwy. 670, 2.3 mi NE of its junction with Hwy. 46, 2 May 1986, Rettig 1523 (NYS**); Route 670, 2.2 to 2.3 mi by road N of Route 46, 11 Apr 2004, Werier 1983 (BH**, MICH, VPI); along Hwy. 712, 7.6 mi N of its junction with Hwy. 58 in Edgerton, 2 May 1986, Rettig 1525 (MO, NYS**); 7.7 to 7.8 mi by road N of Route 712 from Route 58 in Edgerton, 11 Apr 2004, Werier 1972 (BH**, MICH, VPI), Werier 1979 (BH**). **Buckingham Co.:** small tributary of David Creek, ca. 1 mi NE of Bent Creek, 9 May 1983, Wieboldt 4635 & Britten (MO**, VPI). **Caroline Co.:** near North Anna River, 10 Apr 2004, Werier 1954 (BH**), Werier 1958 (BH**), Werier 1960 (BH**, MICH), Werier 1961 (BH**, MICH). **Chesterfield Co.:** 7 mi WNW of Winterpock, along S side of Route 360, 0.2 mi E of Appomattox River, 30 Apr 2005, Naczi 10792 (BH, DOV**, MICH). **Culpepper Co.:** 2nd peak, Buzzard Mountain, 11 May 1941, Allard 8589 (VPI*). **Fauquier Co.:** C.F. Phelps Wildlife Management Area, ca. 1.9 mi SW from Kelly Ford, E of Rappahannock River, 1 May 2004, Werier 2168 (BH**, MICH, NCU, VPI). **Henry Co.:** along Smith River about 0.9 mi below state Route 636 bridge and ca. 5 mi NNE of Ridgeway, 28 Apr 1987, Wieboldt 6301 & Wieboldt (VPI**). **Isle of Wright Co.:** near Walters, 6 Apr 1938, Fernald & Long 7775 (GH, PH**). **King George Co.:** 2 mi SSW of Owens, along E side of Route 301, 1.5 mi SW of its junction with Route 218, 29 Apr 2005, Naczi 10778 (BH, DOV**). **Montgomery Co.:** N of state Route 637 at NW end of Coffee Valley, ca. 7 km E of Ellett, 11 May 1993, Wieboldt 8509, Ludwig, Rawinski, et al. (DOV**, MICH**, VPI); N of Coffee Hollow at NW end of hollow, NE of Seneca Hollow Road, 28 Apr 2004, Werier 2138 & Wieboldt (BH**, MICH). **New Kent Co.:** 4 mi N of Barhamsville, along E side of Route 33, 0.5 mi SW of its junction with Route 273, 1 May 2005, Naczi 10822 (BH, DOV**, MICH). **Newport News City:** behind baseball field on Monroe, Fort Eustis, 22 Apr 1974, Appler 1064 & Wieboldt (NCU). **Patrick Co.:** along Spoon Creek ca. 10 mi SE of Stuart, 27 Apr 1983, Wieboldt 4619 (MO**, VPI). **Pittsylvania Co.:** along N-facing bluff of the Staunton River ca. 4 mi N of Straightstone, 23 Apr 1985, Wieboldt 5472 (MICH**, VPI); Boyd Mountain, ca. 3 km NE of Leaksville Junction on Southern Railroad, 28 Apr 1993, Wieboldt 8454 (DOV**, MICH**, VPI). **Powhatan Co.:** Powhatan State Wildlife Management Area, NW of Macon, 11 Apr 2004, Werier 1964 (BH**, MICH), Werier 1968 (BH**, MICH, VPI). **Prince Edward Co.:** 7 mi SSW of Farmville, along tributary of Briery Creek, ca. 0.3 mi N of dam of Briery Creek Lake, S of road 790, 30 Apr 2005, Naczi 10811A (DOV**). **Prince George Co.:** Coggins Point, 4 Apr 1939, Fernald & Long 9699 (GH, PH**). **Shenandoah Co.:** S end of Short Mountain, Massanutten, ca. 3 mi SE of Mount Jackson, 1 May 1982, Wieboldt 4284 & Davenport (VPI**). **Southampton Co.:** by the Nottoway River near Davis School, Indian Road, NW of Courtland, 4 Apr 1940, Fernald, Long, & Pease 11654 (GH**, PH**). **Surry Co.:** W of Claremont, 19 Apr 1942, Fernald, Long, & Abbe 14117 (GH, PH**); ca. 1/2 mi NE of reactors at VEPCO Surry Nuclear Power Station, 13 Apr 1974, Ware 5391 & Wieboldt (NCU). **Sussex Co.:** 4 mi S of Stony Creek, 5 Apr 1937, Fernald & Long 6952 (GH, PH**). **Wythe Co.:** Rock Creek 2.6 km E of community of Cripple Creek, 6 May 2004, Wieboldt 11390 (VPI**).

APPENDIX A

Specimens of *Carex nigromarginata* measured for the ordination (Fig. 3) are marked with a single asterisk; the ones marked with a single or double asterisk were measured for the scatter plot graph and character distribution curves (Fig. 4, 5, and 6).

CANADA. ONTARIO. Norfolk Co.: Long Point, Squires Ridge, 10 1/2 to 13 mi from base of point, 25 May 1980, Reznicek 5496 (MICH**); Long Point, middle of Little Creek Ridges to Gravelly Bay, 15 to 19 mi from base of point, 15 Jun 1980, Reznicek 5636 (MICH**). **U.S.A. ALABAMA. Autauga Co.:** Autauga County 9, W of Ivy Creek, ca. 0.5 mi E of junction with Autauga County 15, 16 Apr 1980, Wiersema 1537 (BRIT**). **Butler Co.:** by county 59, N of Pigeon Creek, 11 Mar 1991, Kral 78407 (BRIT**); by I-65, 4 mi N of exit to AL 106, 26 Mar 2002, Kral 92214 (BRIT**). **Dallas Co.:** ca. 1 mi WNW of Cahaba, 31 Mar 1972, Kral 45340 (BRIT**). **Escambia Co.:** N side of Route 55, ca. 0.5 mi W of Route 41, 19 Mar [19]82, Wilhelm 10013 (BRIT**). **Jackson Co.:** just E of Route 35, 0.1 mi S of junction with Route 40, 21 Apr 2004, Werier 2072 (BH*); off of county Route 33, 8.05 mi by road SE of junction with Route 79, 21 Apr 2004, Werier 2079 (BH**). **Monroe Co.:** E bank of Alabama River above landing at Haines Island, 15 Apr 1980, Wiersema 1482 (BRIT**). **Morgan Co.:** by US 31, 1 mi. S of Lacon, 12 Apr 1970, Kral 38342 (BRIT**). **Perry Co.:** Hwy. 219, 3.0 mi S of Bibb County line, 9 Apr 1986, Rettig 1443 (BRIT**). **ARKANSAS. Bradley Co.:** Warren Prairie Natu-

ral Area, SE of Warren, 17 Apr 1986, *Rettig 1494* (MO**); Warren Prairie, ca. 15 mi W of Monticello, 3 Apr 1983, *Sundell 2962* (BRIT**); about 1 mi W of Hermitage, 18 Mar 1995, *Hyatt 6161* (MICH**). **Calhoun Co.:** Hwy. 160 about 2 mi W of Bradley County, 18 Mar 1995, *Hyatt 6166* (MICH**). **Clark Co.:** Caddo Valley vicinity, 1 May 1995, *Hyatt 7023* (MICH**). **Columbia Co.:** US Hwy. 79 at Ouachita County line, 18 Mar 1995, *Hyatt 6173* (MICH**). **Crawford Co.:** just S of Rudy, 20 Apr 1985, *Castaner 8218* (MO*); Road 220 just S of Lee's Creek, 20 Apr 1985, *Castaner 8224* (MO**). **Drew Co.:** Monticello, A. & M. College Farm, 21 Apr 1937, *Demaree 14558* (MICH**); 2.8 mi S of Lincoln County on US Hwy. 425, 29 Mar 1997, *Hyatt 7287* (MICH**). **[Garland] Co.:** Hot Springs National Park, Mar 1930, *Connell s.n.* (MO*). **Howard Co.:** Saline River at its junction with Hwy. 84, 15 Apr 1986, *Rettig 1474* (MO**). **Miller Co.:** along Hwy. 237, 0.7 mi N of its junction with Hwy. 160, 14 Apr 1986, *Rettig 1470* (BH**); Hwy. 237, 0.3 mi S of junction with Hwy. 134, 14 Apr 1986, *Rettig 1472* (BRIT**). **Nevada Co.:** AR Hwy. 4 at Ouachita County line, 18 Mar 1995, *Hyatt 6172* (MICH**); by I-30, 3.3 mi SW of junction with AR 26, 16 Apr 1999, *Kral 88225* (BRIT**). **Ouachita Co.:** NW of Camden, AR Hwy. 4 loop, 1.6 mi E of AR Hwy. 376 junction, 18 Mar 1995, *Hyatt 6169* (MICH**). **Pike Co.:** 0.3 mi S of Montgomery County on AR Hwy. 369, 15 Apr 1996, *Hyatt 6938* (MICH**). **Polk Co.:** Ouachita National Forest, Along Forest Service Road 38 to Shady Lake, 3.2 mi N of its junction with Hwy. 246, 15 Apr 1986, *Rettig 1477* (MO**); Ouachita National Forest, along Forest Service Road 38, 1.0 mi N of entrance to Shady Lake at junction with Forest Service Road 508, 15 Apr 1986, *Rettig 1480* (MO**). **Pope Co.:** Long Pool Recreation Area, Ozark National Forest, above Big Piney Creek, 16 Apr 1986, *Rettig 1491* (MO*). **Sevier Co.:** Saratoga Community, 15 Apr 1996, *Hyatt 6307* (MICH**); DeQueen, 1.9 mi N on US Hwy. 71, 23 Apr 1995, *Hyatt 6949* (MICH**). **Scott Co.:** Ouachita National Forest, approximately 5.5 mi S, 1.5 mi E of junction of Hwy. 80 and business loop Hwy. 71 in Waldron, 9 Apr 1999, *Morse 2843* (BRIT**); Ouachita National Forest, approximately 2.5 mi S, 3.0 mi W of Boles, 10 Apr 1999, *Morse 2904* (BRIT**). **Sharp Co.:** N of Cave City on 167, 2 mi S of junction with 167/56, 6 May 1979, *Castaner 5667* (MO*). **Stone Co.:** Ozark National Forest, Sylamore District, T16N, R11W, S15, NW4 of NW4, 27 Apr 1993, *Hyatt 5251* (MO*). **Union Co.:** S of El Dorado, at a roadside park/welcome center 5.7 mi N of Louisiana on US Hwy. 167, 18 Mar 1995, *Hyatt 6159* (MICH**). **DELAWARE. [NewCastle Co.]:** Newcastle, [no date], *Canby s.n.* (BH*). **DISTRICT OF COLUMBIA. [Washington Co.]:** Brookland, 14 May 1899, *Holm s.n.* (MO*); Washington, [no date], *Vasey 187* (BH**). **FLORIDA. Gadsden Co.:** near Flat Creek, general vicinity of Sycamore, 6 Mar 1977, *Godfrey 75723* (BRIT**); N of FL Route 20 between Ochlockonee River and Hosford, 15 Mar 1975, *Godfrey 74186* (BRIT**). **Liberty Co.:** ca. 6 mi NE of Bristol, N of Route 12 just W of its junction with Route 271, 14 Mar 1994, *Naczi 3620* (BRIT**). **GEORGIA. Clarke Co.:** near Winterville, 2 Mar 1929, *Miller & Maguire 297* (BH**); GA State College Agricultural Farm, 9 Mar 1929, *Miller & Maguire 298* (BH**); Princeton Woods, S side of Oconee River, 6 Apr 1929, *Miller & Maguire 300* (BH*). **Dade Co.:** E side of Route 136, 3.55 mi by road NW of junction with Route 189, 20 Apr 2004, *Werier 2067* (BH**). **Lincoln Co.:** near summit of Graves Mountain, 5 Apr 1939, *Clausen & Trapido 3794* (BH*). **Rabun Co.:** SE of Glade Mountain, 17 Apr 1949, *Smith & Duncan 9333* (BH**). **Upton Co.:** Dripping Rocks, 30 Mar 1948, *Smith et al. 3667* (BH**). **ILLINOIS. Alexander Co.:** Shawnee National Forest, Jonesboro Ranger District, Compartment J-104, 5 May 1994, *Phillippe 23977* (MICH**). **Union Co.:** Ozark Hill Prairie Research Natural Area, Shawnee National Forest, 8 Apr 1992, *Phillippe 19778* (MICH**). **KENTUCKY. Grayson Co.:** along Hwy. 411, 0.4 mi E from Hwy. 85, 27 Apr 1987, *McKinney 2473* (BRIT*). **Lawrence Co.:** above state Route 1690, 0.6-0.8 mi NE of junction of Benbow Road, 12 Apr 1990, *Cusick 28744* (BRIT*). **LOUISIANA. Caddo Parish:** State Line Road 14.8 mi S of junction with Hwy. 171, 13 Apr 1986, *Rettig 1457* (MO**). **Claiborne Parish:** Kisatchie National Forest Caney Ranger district, 10 Apr 1996, *Hyatt 6876* (MICH**). **Grant Parish:** Kisatchie National Forest Catahoula Ranger district, 6 Mar 1995, *Hyatt 6151* (MICH**); Kisatchie National Forest, about 3 mi NE of Williana, 3 Mar 1997, *Hyatt 7865* (MO**); Dry Prong community vicinity, 22 Apr 1996, *Hyatt 6857* (MICH**). **Morehouse Parish:** S of LA 835 by Bryant Main Line Road then E to end of Kitpatrick Road, 30 Apr 1992, *Bryson 11441* (MICH**). **Natchitoches Parish:** Kisatchie National Forest, ca. 1 mi SE of Goldonna at Saline Bayou on LA Hwy. 156, 24 Feb 1998, *Hyatt 7860* (MO**); Kisatchie National Forest, Kisatchie Ranger district, compartment 4, 10 Mar 1998, *Hyatt 7872* (MICH**). **Ouachita Parish:** 3 mi SW Cheniere, 11 Apr 1959, *Kral 8510* (BRIT**). **Rapides Parish:** Brushy Creek Riparian Site, 23 Mar 1998, *Hyatt 7913* (MICH**). **Sabine Parish:** LA 175 at Pleasant Hill, 3 Oct 1967, *Thomas 5635* (BRIT**). **Union Parish:** Hwy. 2, 7.7 mi E of Hwy. 33/15 in Farmerville, 11 Apr 1986, *Rettig 1456* (BRIT**). **MARYLAND. Baltimore Co.:** Summerfield, 7 mi NE of Baltimore, 5 May 1910, *Churchill s.n.* (BH**). **Caroline Co.:** Tuckahoe State Park, W of Cherry Lane, 1.2 mi S from junction with Mason Branch Road, 2 May 2004, *Werier 2177* (BH*), *Werier 2179* (BH**). **Montgomery Co.:** Great Falls, 30 May 1917, *VanEseltine 1302* (BH**). **Prince George Co.:** near Congress Heights, 25 May 1915, *VanEseltine 385* (BH**). **MISSISSIPPI. Attala Co.:** 5.5 mi SSE of McCool, 12 Apr 1986, *Bryson 4152* (MO**); 2.6 mi SSE of Attala-Carroll County line along MS Hwy. 35, 12 Apr 1986, *Bryson 4138* (MO**). **Holmes Co.:** Holmes County State Park, 16 Mar 1968, *McDaniel 10376* (BRIT**). **Kemper Co.:** White Horse Mountain, ca. 10.5 air mi N of Dekalb, 6 Apr 1972, *McDaniel 15865* (BRIT**). **Lafayette Co.:** 4.2 mi S of intersection of MS Hwys. 7 and 6 bypass, s of Oxford, 9 Apr 1987, *Bryson 5327* (MO*). **Leake Co.:** near Yockanookany Creek, ca.

8 mi WSW Carthage, 2 Apr 1972, *McDaniel 15819* (BRIT**). **Oktibbeha Co.:** 0.5 mi NW of Sturgis, Hannah Hill, 20 Apr 1989, *Bryson 8463* (MO*). **Winston Co.:** W Betheden Lutheran Church, 6 Mar 1974, *Bryson 318* (BRIT**); 2.5 mi NE Louisville, 6 Mar 1974, *Bryson 317* (BRIT**). **MISSOURI. Butler Co.:** Poplar Bluff Bottomland Hardwood Natural Area, 24 Apr 1982, *Castaner 6749* (MO*). **Callaway Co.:** 0.25 mi E of Williamsville, 25 Apr 1997, *Summers & Vanderbilt 8062* (MO**). **Carter Co.:** Mark Twain National Forest, 3 mi S of Van Buren off Hwy. 103 in Spring Valley, 6 May 1995, *Summers & Wallace 7334* (MO*). **Laclede Co.:** Mark Twain National Forest, Gasconade River, 2 mi W of Adam Ford, 24 Jun 1995, *Summers 7460* (MO**). **Madison Co.:** 8 mi S of Twelve Mile Creek, along Hwy. 67, 26 Apr 1987, *Castaner 9602* (MO*). **Shannon Co.:** Middle Hollow, 7 May 1997, *Brant 3687* (MO*). **Ste. Genevieve Co.:** Hickory Canyon Natural Area, ca. 2 mi N of Sprott on Hwy. EE, 23 May 1996, *Summers et al. 7800* (MO**); Pickle Springs Natural Area, ca. 0.25 mi E of Hwy. AA, ca. 1.5 mi SE of Hwy. 32, 20 Apr 1996, *Summers et al. 7695* (MO**). **Wayne Co.:** Mark Twain National Forest, 2 Apr 1998, *Brant 3882* (MO*). **NEW JERSEY. Somerset Co.:** Chimney Rock, Bound Brook, May 1935, *Edwards s.n.* (BH**). **[Gloucester Co.]:** Newfield, 20 May 1873, *Ellis s.n.* (BH**). **NEW YORK. Orange Co.:** Town of Warwick, SE end of Bellvale Mountain, N of village of Greenwood Lake, SW of Route 17A, 7 May 2003, *Werier 1506 and Barbour* (BH*). **NORTH CAROLINA. Davidson Co.:** a little E of Tuckertown Road, 1.5 mi by road S of Route 49, 14 Apr 2004, *Werier 1992* (BH**), *Werier 1993* (BH*), *Werier 1994* (BH**); S of Route 49, 0.6 mi E of bridge over Yadkin River, 14 Apr 2004, *Werier 1996* (BH**). **Montgomery Co.:** Flint Hill Road, ca. 2.5 mi by road W of Lovejoy Road, 13 Apr 2004, *Werier 1986* (BH**). **Swain Co.:** 100 yards inside Graham-Swain County line on US 129, 11 Apr 1983, *Reznicek 7132* (MO*); SE of Route 19 at junction of Route 28, 26 Apr 2004, *Werier 2128* (BH**). **Transylvania Co.:** N side of Route 64 just E of Lake Toxaway, 18 Apr 2004, *Werier 2044* (BH**). **OHIO. Gallia Co.:** Symmes Creek Road, 1.25 mi S of Gallia-Centerpoint Road, 9 Apr 1986, *Cusick 25054* (MICH**). **Jackson Co.:** Camp Canter's Cave, N of Caves Road, 16 Apr 1990, *Cusick 28752* (MICH**). **Scioto Co.:** N side of Dark Lick Road 3/4 mi E of Disterdick Road, 19 Apr 1990, *McCormack 2094* (MICH**). **OKLAHOMA. LeFlore Co.:** 3 mi W on SH 63 and 0.5 N of Arkansas/Oklahoma state line, 4 Apr 1992, *Magrath 18592* (MICH**); W side OK Hwy. 144 2.1 mi SE of Little River bridge at Honobia, 19 May 1993, *Reznicek 9353* (MICH**). **PENNSYLVANIA. Bedford Co.:** 0.75 mi WSW of Breezewood, 16 May 1946, *Berkheimer 7110* (BRIT**). **Berks Co.:** Robeson Township, N side of outlet from Birdsboro Reservoir, 3 May 2004, *Werier 2185* (BH**). **[Carbon Co.]:** ca. 1/8 mi W of Lehigh Gap L.V.R.R. station, 22 May 1927, *Pretz 12925* (BH**). **Centre Co.:** Ingleby, 2 mi E of Coburn, 5 May 1936, *[Wahl] 2486* (BH**); Ingleby, 6 Jun 1937, *Clausen & Wahl 2528* (BH**); abandoned railroad at Ingleby, 7 May 1977, *Keener 3401* (MO**). **Huntingdon Co.:** ca. 2.5 mi E of McAlevys Fort, 29 May 1979, *Lahham & Keener 15* (BRIT**). **Potter Co.:** Town of Pike, N of US Route 6, ca. 0.5 mi NW of Galetton, 26 May 2005, *Werier 2546* (BH*). **SOUTH CAROLINA. Anderson Co.:** 2 mi SE of Savoy Springs, 6 Apr 1939, *Clausen & Trapido 3805* (BH**). **Chesterfield Co.:** N side of Route 9, W of Thompson Creek, W of Zoar Road, 15 Apr 2004, *Werier 2003* (BH**). **Darlington Co.:** Society Hill, [no date], *Curtis 106* (BH**). **[Darlington Co.]:** W of Hartsville, 9 Apr 1921, *Norton C21* (BH), *Norton s.n.* (BH**). **Greenville Co.:** 20 meters SE from Route 414, 2.1 mi by road NE from Route 276, 18 Apr 2004, *Werier 2028* (BH*). **Lancaster Co.:** E of Route 601, S of Flat Creek, 16 Apr 2004, *Werier 2011* (BH**); E of Great Falls and a little bit E of the Catawba River, 17 Apr 2004, *Werier 2024* (BH**). **Oconee Co.:** SE side of Stump House Mountain, 7 Apr 1939, *Clausen & Trapido 3811* (BH**). **Pickens Co.:** just N of Route 288, 1.2 mi by road E of Pumpkintown and Route 8, 18 Apr 2004, *Werier 2031* (BH**), *Werier 2034* (BH**), *Werier 2035* (BH**); just E of SSR 69, 0.1 mi by road N from Route 288, 2.5 mi by road E from Route 178, 18 Apr 2004, *Werier 2039* (BH*). **TENNESSEE. Davidson Co.:** Dyer Observatory, 30 Mar 1976, *Kral 57466* (MO*). **Grundy Co.:** NW of state Route 50, 5.7 mi by road SW from junction with Route 108, 22 Apr 2004, *Werier 2093* (BH**). **Polk Co.:** N of Route 64, 11.1 mi by road E of junction with Route 314, 20 Apr 2004, *Werier 2059* (BH**). **Sevier Co.:** N of Little Cove Creek Road, 4.8 mi by road E of Wear Valley Road, 27 Apr 2004, *Werier 2134* (BH**). **TEXAS. Cass Co.:** Hwy. 155, 1.5 mi SW of its junction with Hwy. 59 in Linden, 14 Apr 1986, *Rettig 1469* (MO**); 3 mi SE Hughes Springs, 2 Apr 1979, *Kral 63243 and Carter* (BRIT**). **Houston Co.:** FR 227, 0.1 mi NW from junction with Davy Crockett Road (NF 526), 10 Apr 1990, *Jones 4309 and Wipff* (MO**). **Smith Co.:** Tyler State Park, N of Tyler, 13 Apr 1986, *Rettig 1465* (BRIT**). **Upshur Co.:** Hwy. 155, 9.5 mi SW of its junction with Hwy. 259 in Cedar Springs, 14 Apr 1986, *Rettig 1467* (MO**). **VIRGINIA. Botetourt Co.:** NW of Route 615, 0.7 mi by road N of junction with Craig Co. line, 29 Apr 2004, *Werier 2148* (BH**). **Brunswick Co.:** 7.7 to 7.8 mi by road N of Route 712 from Route 58 in Edgerton, 11 Apr 2004, *Werier 1969* (BH**), *Werier 1971* (BH**), *Werier 1975* (BH*); Route 670, 2.2 to 2.3 mi by road N of Route 46, 11 Apr 2004, *Werier 1981* (BH**). **Caroline Co.:** near North Anna River, 10 Apr 2004, *Werier 1952* (BH**), *Werier 1957* (BH**), *Werier 1959* (BH**). **Craig Co.:** Potts Mountain ca. 6 mi NW of New Castle, 18 May 1983, *Wieboldt 4657* (MO*). **Powhatan Co.:** Powhatan State Wildlife Management Area, NW of Macon, 11 Apr 2004, *Werier 1963* (BH**). **WEST VIRGINIA. Mingo Co.:** county Route 3-2, 1 mi SE of county Route 2 at Selwyn, 17 Apr 1991, *Cusick 29399* (MICH**). **Pleasants Co.:** above junction of McKim and Middle Island Creeks, 10 May 1984, *Cusick 23333 and Ortt* (BRIT**). **Ritchie Co.:** county Route 8, 1 1/2 mi S of US Route 50, 8 May 1985, *Cusick & Ortt 24185* (BRIT*). **Tyler Co.:** junction of county Routes 58 and 62 at Fairview Church, 3 May 1989, *Cusick 28021 and Ortt* (BRIT**).

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